THE

ELECTRICAL REVIEW.

VOL. XXXI. AUGUST 26, 1892. No. 770

CONTENTS:

	PAGE
Code-Signalling for Lighthouses	245
More Quackery Quashed	246
The Electric Light on a United States Battle-ship	246
American Engineering Notes	248
Australian Electrical Notes	249
Reversal of Polarity in Plating Dynamos	250
Reading in Railway Carriages (*illustrated*)	250
A Few Hints to Dynamo Tenders	251
The Eickemeyer-Field Manufacturing Company	252
A Century of Gas Lighting	252
Water-power.—II. (*illustrated*)	253
The Lundell Dynamo (*illus.*).—Electric Mining at Bleiberg (*illus.*)	255
The Relative Value of Exhaust Steam	257
Barking Road-Canning Town Electric Tramcars	258
Railway Train Lighting	259
The Development of the Telephone	260
The British Association: A Review	260
An Electric Locomotive (*illustrated*)	262
The Current that Cures.—II.	263
Notes	264
Business Notices, &c.	267
City Notes, &c.—City of London Electric Lighting Company	267
Telephone Company of Ireland.—Traffic Receipts	268
Share List of Electrical Companies	269
The British Association:—On the Clark Cell	270
National Physical Laboratory.—Wave Propagation in Magnetic Materials.—On the Dielectric of Condensers	271
Nomenclature of Units.—Slow Oscillations Produced on Discharging Electric Condensers of Great Capacity (*illus.*)	272
Photographs of Electric Discharges (*illustrated*)	273
New Patents—Abstracts of Published Specifications	275
Correspondence:—Dynamos for Continuous Work.—The Output of Dynamos.—Electric Sub-station Supply	276

J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893,

IS NOW IN COURSE OF PREPARATION.

Advertisers are respectfully requested to send in their Orders and Revised Proofs as early as possible.

Scale of charges for Advertisements and Insertions, with examples of various insertions sent, post free, on application to

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGEKKAY, LONDON." Code A B C. Telephone No. 517.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *Foreign Countries* (except those mentioned below), per Year, £1 1s. 8d. *Exceptions.*—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (*viâ* Brindisi), Phillipine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 3s. 10d.

BINDING.—Subscribers' numbers bound, including case, for 3s. 6d. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

CODE-SIGNALLING FOR LIGHTHOUSES.

THE suggestion of introducing a system of code-signalling, for light-houses and ships, in which the name of the station or vessel shall be indicated by flashes, according to the Morse alphabet, instead of the empirical, distinctive, signals now in use, continues to be discussed in naval quarters, with the result, apparently, that things are to remain as they are, at least as regards the mercantile service.

At first sight the present system of arbitrary flashing seems clumsy, complicated, and irrational, and we are led to wonder why more collisions do not occur. For example, notice the succession of signals now stationed about the Channel, as seen by a vessel steering for London from the west. The first light made for is upon the Bishop Rock, on the Scilly Isles, which gives two successive flashes of about 4 seconds duration with 4 seconds between each flash, and then 48 seconds interval. St. Agnes Light, also on the Scilly Isles, is the next—it is a revolving light appearing every ½ minute. Then appears the flash-light from the "Seven Stones"—three successive flashes. Following this is the Longship's Light at Land's End—an intermittent light seen every minute. Before coming upon the two beams from the electric lights on the Lizard, the Wolf Rock is passed. This is marked by a revolving light, alternating red and white, every ½ minute. The Eddystone now shows its group flashes: two in succession, each of 2½ seconds duration, divided by an eclipse of 4 seconds, the second flash followed by 21 seconds of darkness. At Start Point is a revolving light, rotating every minute. Passing the fixed oil beams which distinguished Portland, we make for the lights upon the "Shambles;" two successive flashes in the following order: a flash of 5 seconds duration, an eclipse of 6 seconds, a flash of 1½ seconds, followed by an eclipse of 17½ seconds. At Anvil Point there is a flash every 10 seconds. The Needles show an occulting light, with an eclipse of three seconds every minute. St. Catherine's Point is a fixed electric light flashing every 30 seconds. The next light, Ower's light vessel, is similar to that upon the Wolf Rock, a revolving light, alternating white and red every half minute. Beachy Head shows a flash every 15 seconds. We now have, upon the Sovereign shoals, a succession as complicated as the Eddystone, *i.e.*, three flashes in the following order: a flash of 1½ seconds, an eclipse of 2½ seconds, a flash of half a second, eclipse of 2½ seconds, flash of half a second, eclipse of 35½ seconds. Dungeness introduces a little variation by showing a "twinkler"—a succession of flashes of about 2 seconds in duration—in addition to the fixed light. The South Foreland has similar lights to the Lizard. The South Sands Head light shows two flashes, first a flash of 1½ seconds duration, then an eclipse of 6 seconds; a flash of 5 seconds follows, and, lastly, an eclipse of 17½ seconds. Upon the East

Goodwins is a green revolving light, rotating once in 15 seconds. The North Sands Head shows a group flash: three quick flashes in succession, followed by an eclipse of 36 seconds. The last light is that upon the North Foreland, an occulting red light which disappears every half-minute for 5 seconds and shines for the rest of the time.

A comparison of these signals with one another shows that in some cases the same combination is used for more than one station, while in others signals or parts of signals are likely to be mistaken for others or parts of others. Before condemning the system on this account, however, we must remember that the officer on watch has two very efficient checks to apply when he is in doubt, the compass and the sounding line, and with a proper use of these he can scarcely mistake his locality. In fair weather there is, of course, no difficulty, as each station is passed in regular sequence; the only true test of the efficacy of a system is its capability of showing instantly, at a single glance, in foul weather, the direction of danger. It is very doubtful if the introduction of code signals would help to attain this degree of efficiency. To begin with, the officers would have to undergo a special training, and unlearn the present system; this, especially among the senior men, would be resented. In the case of the juniors it might be made an obligatory subject for the entrance examination, and it would probably be forgotten a week afterwards, as easily as the semaphore signals, which are obligatory, are forgotten by them. Again, the names of stations would have to be abbreviated, or the time taken to signal them would be much too long. This would lead to a code within a code, which would be far more confusing than the present system, especially to foreigners.

When sufficient brilliancy has been attained, there seems no reason why electrical engineers should not apply a universal system of illuminated letters to lighthouses, as they are doing for the theatres, not necessarily to displace the flash lights, but to direct the officers when they are at close quarters with the rocks.

MORE QUACKERY QUASHED.

ALL our readers have probably heard of "Matteism," and have read of the "wonderful cures of *bonâ fide* cancer cases," by means of the celebrated coloured "electricities," with a shrug of the shoulders, feeling, perhaps, that the subject was almost too contemptible for anything else. When, however, the editor of the *Review of Reviews* began to take the matter up, Count Mattei and his remedies necessarily became notorious. Fortunately, the "Mattei boom" has been shorter lived than many of its contemporary systems of quackery; for we can but reason that the public will cease to patronise what has suffered such a terrible exposure.

In response to certain representations made by Lady Paget and by Mr. W. T. Stead, to whom all honour is due, a committee of investigation was formed in the early part of last year to enquire into the claims of Count Mattei and his followers to the cures of cancer "without the knife," by the aid of liquids, which they termed "electricities." This committee suffered some changes, but eventually consisted of Mr. H. A. Reeves, F.R.C.S.E., Mr. John Hopkins, F.R.C.S., and Mr. G. W. Potter, M.D. Five cases of cancer were under their observation for exactly a year, during which period the patients were systematically treated with the electricities."

We pass over the history of this treatment (it can be read by anyone in the *British Medical Journal* for August 13th, pp. 369—370), and the attempts of the Matteists to escape from the investigation they had directly courted. We are concerned only with the conclusion arrived at by the committee of experts of high medical standing. What do they say?

Dr. Potter, the chairman of the committee, in his report, states that "Matteism, in the deliberate judgment of the committee, consists of vulgar, unadulterated, unredeemed quackery. Mr. Stokes analysed the 'electricities,' the potion of the Matteists, and found them to yield no other reaction than that of plain distilled water. The results of administering these substances to patients entirely coincided with the results of chemical analysis. Water is the potent magician which, when taken in unquestioning faith, makes some of the deluded victims of Matteism feel that they are relieved of their pains."

The story is as old as the hills. Seneca long ago said, *Pars sanitatis velle sanari fuit.* The savage trusts to his amulet; the civilised man, both in the upper and lower circles, submits himself with childish, if not childlike, simplicity, to the pretences of the quack, and girds himself with his belt. It is a strange world; but, such as it is, open and honourable medicine has to live and work in it, and must make the best it can of such an environment.

As we reflect upon this investigation and its results, the idea occurs to us whether certain other systems of alleged quackery could be submitted to an analogous examination. For example, would the gentleman who lives at the corner of Rathbone Place and quotes Horace (*vide* ELECTRICAL REVIEW, p. 243), undertake to allow his belt system to undergo a searching trial at the hands of properly qualified medical and electrical experts? If the system came out of the ordeal triumphantly he would never require to spend his annual thousands on advertisements, and we would undertake to for ever hold our peace. But, perhaps, this gentleman who is so fond of Horace may also remember one of the maxims of the Epicurean school which his poet nicely turned as follows: *Carpe diem, quam minime credula postero!*

THE ELECTRIC LIGHT ON A UNITED STATES BATTLE-SHIP.

IN a recent official report upon the behaviour of the U.S. ss. *Baltimore*, by her commander, Captain W. S. Schley, U.S. Navy, there are a few points of special interest to those who watch the development of electric lighting on men-of-war. It appears that the electric plant in the vessel has, in the main, worked well. The chief difficulties were experienced in the power arrangements, especially in the steam separators and drain-pipes leading from them into the feed-water tank. It occasionally happens, when changing steam from one boiler to another, that quantities of water from "pockets" in the

long steam pipes leading into the dynamo engines rush over into the cylinders of these small high speed engines, with danger and damage to them on account of the drain pipes being rather too small to relieve the trap in time to save the machines. Constant and incessant watch is necessary to prevent these accidents, even though the drain pipes are now larger than originally designed.

The system of lighting and wiring of the ship is most admirable, though the efficiency of the system would, in Captain Schley's opinion, be greatly enhanced in value if, in addition, storage batteries could be added so as to ensure the maintenance of the light for at least twelve hours, in the event of accidents to the machines from the causes named.

The brush and commutator surfaces were at first *insufficient for the work imposed*. This serious oversight, or miscalculation, has now been remedied, new commutators with larger areas and more brush service have been introduced; but at times there is still rather much sparking.

The search lights are recommended to be used with about 45 volts at the lamps, and this uniform voltage is supposed to be maintained by the dead resistance boxes in the circuit. These boxes, however, do not fulfil their purpose, it being ascertained to be immaterial whether the whole or half of the resistance is thrown in, as indicated by the voltmeter outside them in the circuit. Practically, in working one light it has been found better to run direct from the switchboard with about 45 volts, but with two lights in circuit it has been found more difficult, so that the boxes were then used. This defect in the boxes is not to be regarded as an adverse criticism upon the lamps themselves, the power of which depends in a large measure upon the focussing arc and the form and position of the crater at the carbons, where most practice is required to properly manipulate the light.

It is interesting to notice that Lieutenant Sturdy, the officer in charge of the electric lighting, has been able with the force on board to make all the needed repairs or changes required to secure more efficiency in the plant. The report would have been much more interesting to us, however, if details of the system and the names of the makers of the dynamos, &c., had been supplied.

The Development of the Telephone.

IN another column we give some extracts from a correspondence in the *Times* under the above title. On the 23rd inst. appeared a letter from the Duke of Marlborough, and we are glad to note that in the columns of the *Times* itself the change in the Duke's attitude on the question has been ably shown by General Webber. A comparison of the Duke's arguments now and a year ago is a most instructive illustration of the statement that circumstances alter cases. On the questions of the advantages of competition and the possibility of considerably lower rates, General Webber takes up now the line which the Duke of Marlborough took up before. Herein, we think, there is necessity for some warning. We deprecated the reckless statements and loose estimates of the Duke of Marlborough and those who were associated with him, and we think it desirable now to point out once again that there is a difference between telephonic exchange competition and any other industrial competition whatever. Whether the public are likely to see this until it has been proved in practice is another matter. We are inclined to think that the Duke of Marlborough is assuming a little too much in writing as if the arrangement between the National and the New Companies—whatever the arrangement may be, or however much misconception there may be as to its nature—will enable them to control the field entirely. This end is largely attained by the mere fact of an arrangement having been come to. The Duke of Marlborough raised a banner and intimated his intention of fighting under it. Instead he has entered into a mutual arrangement. His action must make it all the more difficult for any others who may be imbued with a desire to raise the same banner, however thorough their motives or their courage. The Duke of Marlborough's explanation is not sufficient. His previous attitude was that of attacking a stronghold; his present is that of sheltering himself within its walls. To be logical, he must either admit that his previous attitude was not warranted, or that he had miscalculated his chances of success. The result of the agitation is instructive. It demonstrates once more the inutility of an agitation which is stirred up instead of arising from natural causes. It illustrates further the danger of accepting the opinions, however strongly expressed, of those who lack the necessary experience to give them weight. Beyond the fact that the Duke of Marlborough's company is now allied with the National Company, we see no reason why his present views and promises should carry any more conviction than those in which he previously indulged. It illustrates, still more strongly, the disadvantages of legislating in a hurry on such matters. Before it was carried through we showed that the Government measure was the New Telephone Company's opportunity, and there ought to be no surprise that the company have availed themselves of it.

A New Property.

IN an investigation on the properties of lamellar bimetallic conductors under the influence of electro-magnetic induction, MM. Ch. Regnier and Gabriel Parrot have reported to the Paris Academy of Science that they have obtained an arrangement recalling the well-known "Faraday's disc," by substituting for the usual copper conductors thin plates of a certain constitution. These plates are composed in the direction of their thickness, of a very magnetic and highly conducting metal, and so placed that the lines of force of the electro-magnet field are perpendicular to this direction of thickness. The flow of induction which proceeds from the north pole is divided into several sheets of parallel lines, which are very close together and which only traverse the metallic portions of the bimetallic conductors, the tubes of force becoming cylindrical. In this arrangement of conductors MM. Regnier and Parrot found that the available energy increases at a rate which is practically proportional to the height of the conductors. They constructed a small machine on this principle, and obtained with a load of 750 kilogrammes and a velocity of 500 revolutions, 32,000 watts: and this they found worked out to an output of 42 watts per kilogramme of the machine. Further details of this newly discovered property of lamellar bimetallic conductors may be found in a paper in the *Comptes Rendus*, August 8th.

Geometrical Methods.

MONS. W. RECHNIEWSKI has recently made a very pretty application of the geometrical method of attacking alternating questions to the investigation of effects in cables. The question is one of some difficulty, but yields very readily to this method of attack. Those interested in the question will find the articles in recent numbers of *L'Electricien*.

AMERICAN ENGINEERING NOTES.

SOME LESSONS IN RAPID TRANSIT.

UNDER this head in the *Engineering Magazine*, Mr. Louis Heilprin discusses the question to the limited extent only of the requirements of the City of New York. Perhaps no city in the world is worse situated than New York for the business to which Americans choose to put their, as yet, metropolitan city. By nature the location of New York is specially that of a maritime city. Americans have made it a business centre for their railroads, and have done their best, and very successfully too, to stamp out all results which naturally accrue to a grand seaport location. Were New York in English hands it would bristle with masts and spars. As it is it forms merely a convenient terminus for foreign lines of steamships, and the bulk of American business in New York Bay and Harbour seems to be confined to ferrying railroad cars about, and "penny" steamboats. By the close of the century the City of Chicago will have beaten New York in population, and New York will go crazy with jealousy, and her citizens will go for tariff reform, which is the one thing needed to put New York, and the sister cities of Brooklyn, Garden, and Long Island cities ahead of London in size. As matters stand, however, New York, as regards its internal railroad traffic, is much in the position that London would be in if all business were transacted in the eastern end of Whitechapel and everyone lived at Fulham; if every main line station but Euston were removed south of the Thames, and there were no omnibuses and no cabs to be had under half-a-sovereign. New York occupies its present position because its Dutch founders saw its grand situation for shipping. Englishmen firmly established what the Dutch began, but it remained for the "genius of free and enlightened Americans" to condemn the city to other purposes rather than to copy "servilely" the lead of the detested English, and this it is that gives so very much weight to the rapid transit problem in this City of New York, which was founded by two maritime nations on a thoroughly Free Trade site, than which none could be worse for its present purposes. The rapid transit problem is so difficult because there is so great a concentration of workers and no diffusion of work as there should be round 150 miles of water frontage. It makes one laugh at the dense ignorance of the "smartest" folk on "airth," to see such a waste of wealth, and, again, to see the timorous way they go about solving the transit problem as though the future of New York could for ever be trammelled by the McKinley gang.

Mr. Heilprin certainly does grasp the truth of this question. He sees full trains now on the elevated roads and perceives that if the train capacity could be made to provide every one a seat, there would be an instant accession of probably 25 per cent. of passengers. The present writer rarely could obtain a seat to or from the City Hall, and thousands like him walked rather than stand in the stuffy cars, for the trams, also, are all full.

Broadway is densely crowded, and the Bowery is fairly busy, but other streets, running up the island, are nearly deserted as thoroughfares, and of the elevated lines, 3rd Avenue and 6th are the very busy ones. Traffic follows the median line of Manhattan Island, and requires to be accommodated along that line. About 100,000 per hour is the fastest rate at which the four elevated lines receive passengers during the short busy time of the day, and this would be made a higher figure by a better accommodation. Mr. Heilprin shows that a better speed would not improve the capacity of the lines, for the headway of trains could not be well reduced, and might require even to be increased for safety with higher speeds, in which case high speed would mean reduced accommodation. High speed would merely get a bigger service per car, but not per hour. Hence it is the busier a line becomes, and the closer the trains run, the slower will be the speed for equal safety, and were a high rate of speed attempted for all classes of travel, long and short hauls, then 10 tracks, all used in one direction, could not be relied upon to convey 125,000 passengers per hour with comfort and safety, and with a satisfactory system for New York of to-day would require, in place of the existing 10 tracks, some 18 or 20 tracks; but in 10 years time there will be another half million people to deal with, even with the present financial policy of America, and Mr. Heilprin considers this would add 100,000 in each direction daily to the rapid transit passengers, and this would imply at the rate of 20,000 per hour during the busiest hour of the day, whilst there may, and probably will be, a further removal of residents from down-town to up-town localities, all which would increase the stress. The immediate future, therefore, demands quite 25 sets of rails, which is 50 per cent. beyond the accommodation possible with existing elevated roads, and the eight proposed underground tracks, and when these have been completed, New York will be no nearer solution of her transit problem than now. Indeed, if we look at London with its many radial lines, its tramways, which deliver upon the City boundaries, and its omnibus traffic, far surpassing anything even possible in New York, all, too, to serve a huge district over which business is spread, we are compelled to admit the difficulty in which New York finds itself, for the London railroads must, as compared with New York, have a capacity equal to 70 or 100 sets of rails.

The rapid transit proposals now under consideration do not, however, provide for more than four tracks south of Union Square, which, as Mr. Heilprin remarks, is preposterous, and why, he asks, should the scheme be crippled in order to secure a line which can be compressed under Broadway, which is really by no means well named, for it is quite a narrow street, when better accommodation could be had under the Bowery. This is a point of grave moment, for the failure of the London underground lines, apart from their bad management is largely due to their faulty location off the stream of traffic. To be a success there should be some means of taking in passengers on Broadway and delivering them to the stations for which the travelling side walk idea in subways presents itself as a likely means of conveyance, especially in winter time, when a sheltered subway would be used cheerfully; whereas, as now, people would fight for a seat on a Broadway tramcar in preference to walking across the city, and even a short distance along any street at right angles to Broadway. Those who know the temper of the cutting winds from the North and East rivers in an American winter will best appreciate the objection to stations any serious distance off the main lines of traffic.

Mr. Heilprin does not suggest a way out of the difficulty, but he does plainly indicate what will not do. What will ultimately be done it is not well to prophesy. Probably there will be a good many bridges across the North and East rivers giving high level access to New York, like the present East River Bridge affords, thus converting the city into one with radial approaches, for the problem of affording accommodation upon an island of great length, and but two miles wide, is almost out of the range of practice. New York has overgrown itself in fact.

HEAT UNITS.

Mr. Peabody, M.Am.Soc.M.E., objects to the customary method of stating steam engine performances in pounds of steam used per hour, because the value of a pound of steam depends upon its pressure and quality, and he advocates the use of the British thermal unit for the purpose, which he states is equal to 778 foot-pounds, departing in this from the value of the mechanical equivalent as determined by Joule, viz., 772, from which we think there is hardly sufficient evidence to warrant us yet in departing. As he points out, the method he advocates has the advantage that it may be applied to any heat engine other than steam. If an engine consumes s pounds of steam per hour per horse-power supplied at a pressure, p, and exhausted at a pressure, p_o, then the thermal units per horse-power per minute will be $s\,(r\,x + q - q_o) \div 60$; where r is the heat of vaporisation at pressure p_1, q and q_o are the heats of the liquid at pressures p and p_o, and x is the percentage of dryness of the steam; where the steam consists of 2 per cent. water, then $x = \cdot 98$. He deduces the above expression on the assumption that all the steam passes through the cylinder; any steam passing through jackets, re-heaters, &c., requiring separate calculation to give a correct idea of cost of running the engine. He quotes, then, the triple engine in the laboratory of the Massachusetts Institute of Technology, which used 13·73 pounds of steam per horse-power, 10·86 of which passed through the cylinder, and 2·87 were condensed in the jackets, and he calculates the B.T.U. per minute from the known dryness, ·988, and the boiler pressure 157·7, with 4·5 lbs. back pressure as 191·1 for the cylinder, and for the

jackets as $2{\cdot}87 \times r \div 60 = 40{\cdot}6$, as there is no further loss of heat in the jackets, for the water goes directly back to the boiler. Hence the total heat consumed is 231·7 units, a horse-power is 33,000 ÷ 778 = 42·42 units per minute; and this constant, divided by the heat actually used per horse-power, gives the actual engine efficiency. In the test quoted we get 42·42 ÷ 231·7 = 0·183.

In a perfect engine the efficiency is $\frac{T - T_0}{T}$, and this expression for the engine in question gives efficiency as 0·2485, so that the relative efficiency of the actual and perfect engine becomes $\frac{\cdot183}{\cdot2485} = \cdot736$, a sufficiently remarkable result, and one showing that steam engine efficiency is really very much near its possible maximum than it is so customary to consider it. Calculating the steam consumption from Carnot's cycle for the engine in question, the author finds 11·9 lbs. per hour, which is ·869 of what the engine actually did use, and not ·736 as found above, and to such an extent is misleading, and the B.T.U. method is better. Clearly the discrepancy arises in the jackets, and the consumption of B.T.U. per horse-power minute, when compared for the two cycles, will give the same result as the comparison of the efficiencies.

After dealing mathematically with the thermal question, the author, admitting that his work is but a new presentation of the subject, concludes that it is useless attempting to arrive at any method of engine design from theoretical considerations so long as cylinders are made of conducting material, such problems being more curious than useful. He might have added that practical men find little difficulty in designing an engine to give better results than have been secured by the so-called theorists, and we see in the case of the late Mr. Willans how the educated practical engineer is able to evolve a method of engine performance from a combined knowledge of theory and practice which completely outstrips mere paper theory.

The Size of Engines for Electric Railways.

Under the head of "Points on Power Stations," Mr. W. Lee-Church discusses in the New York *Electrical Engineer* the question of engine sizes for the power stations of electric railroading. He starts from the text: "Bear in mind that the engine in an electric railway power station is normally an under-loaded engine, not an over-loaded engine," and from this proceeds to draw attention to the fact that the engine must be too large for its average duty, in order that it may be able to exert at intervals the maximum energy required for those concentrations of load which must come upon it when an abnormal number of cars or trains require to be started from rest, perhaps, too, when others are ascending grades; and he points out the fallacy of supposing that the average load for the day represents the true performance of the engine upon which an estimate of fuel consumption can be based. It is well recognised that an over-loaded engine is more likely to be an economical one than an engine under-loaded, for every engine has a certain amount of internal resistance acting against its economy, just as does its superficial area of radiation, and these considerations must tell in favour of the smaller engine. For every period of maximum effort, there must be other periods of effort below the daily average, and the greater the range of effort, the worse will be the performance of the engine.

If an engine runs against a useful load for two-thirds of its working hours, it must be running idle for one-third, and if it requires, say, 20 horse-power to move the idle engine at, say, 30 lbs. of steam per horse-power, we get 600 lbs. of steam hourly during a third of a day to be added to the steam consumption during two-thirds, that is, 300 lbs. per hour. Should the engine, when doing useful work, consume 2,400 lbs. of steam per hour, the idle period will add on the balance-sheet the extra 300 lbs. It is thus easy to see that our estimate of fuel must not lose sight of the frictional resistance of the engine, and that the smaller the engine, consistently with getting over its short periods of maximum duty, the more economical it is likely to prove in the ledger.

Such, though with different figures, is the gist of Mr. Church's reasoning, in which all must concur, and the conclusion he draws is that every electrical horse-power hour will account for sometimes as much as 50 lbs. of feed water.

Mr. Church promises to return to the subject, and to make plain certain improvements in engine design, which will give a uniformly high duty under all and wide load variation. He does not say how the idle time will be accounted for, but, apart from storage batteries, which if sufficiently durable and rapid in action, ought to be capable of rendering it possible to run an engine of the proper size at its best and most economical rate, there are no doubt means of accomplishing the end which may be brought within our reach. Such a means, for example, would be an air compressor, worked by the engine, to force air into a large receiver, from which it could be instantly made to run back, and the compressing piston would become a working piston.

The load diagram given by the author as a bad case of fluctuation, shows such short periods of maxima averaging one per minute on a diagram 7 inches long, representing 22 minutes, that the thought naturally occurs to us, could not something be contrived of the accumulator type—a heavy weight interposed between engine and dynamo, or, rather, on a shunt, so as to come into action to help over the peaks of the diagram?

We await Mr. Church's revelations with interest; but, as the Americans would say, What is the matter with storage batteries that they will not do? If not at present equal to such work, someone may yet devise a battery that is.

AUSTRALIAN ELECTRICAL NOTES.

[FROM OUR OWN CORRESPONDENT.]

On Sunday, July 3rd, some very interesting experiments in connection with long distance telephony were made on the new copper line between Sydney and Melbourne. In Sydney we swear by the Hunnings transmitter; in Melbourne the officials swear by, and the public swear at, the Berthon-Ader telephones. So, at the Sydney end, a number of various types of transmitters and receivers were connected to plug switches so that any desired instrument could be quickly put into circuit, and a Hunnings transmitter, such as we use in Sydney, was sent down to Melbourne and exchanged for a Berthon-Ader in order to institute comparisons at both ends. Amongst the instruments in Sydney were two Hunnings, a Consolidated, a Blake, a Gower-Bell, a Berthon-Ader and an Ader multiplex transmitters, and double-pole Bell, Ader, and Mix & Genest receivers.

The copper wire only extended as far as Albury, a distance of 386 miles, the remaining 190 miles being completed by an iron wire from Albury to Melbourne. The speaking to Albury was remarkably clear, voices being easily recognised; the speaking to Melbourne, though perfectly distinct, was, of course, fainter. The striking of a high-toned bell was heard very clearly, and songs were sung at both ends with excellent results. On the whole, the decision was rather in favour of the Hunnings transmitter and double-pole Bell receivers, none of the other transmitters being of any use. The battery used consisted of fourteen gravity Daniell cells placed seven in series and two in parallel.

Some of the most interesting results obtained were some due to induction, by which Tamworth, 280 miles north of Sydney, heard on a separate wire the conversation between Sydney and Melbourne, and, on one occasion, even caught a remark made by Melbourne which Sydney did not hear, or could not distinguish. The northern line on which Tamworth is connected, is also a copper wire, and runs on the same poles as the Melbourne line as far as Strathfield Junction, a distance of eight miles. Some very amusing results were also obtained by the induction on our line from some of the railway telephone lines—telephones connected from signal box to signal box and station to station, &c., for railway working only, but very often used, especially on Sundays, when there is practically no traffic for purposes of private conversation. One conversation overheard between a man and a girl was specially interesting, much amusement being caused when the couple, unconscious of listeners, began "blowing kisses" to each other through the telephone and afterwards describing the effect produced. First was heard a girlish giggle followed by a faint smacking sound,

and then a shrill treble voice asking with a tremor, "Did you get that one; shall I send you another?" answered by a gruff bass, saying "Wait a bit till I've recovered from the first one," and so on. The girl then sang "In Old Madrid," which came out remarkably clearly, and was much appreciated both by the person it was intended for and the listeners on the free list.

Every now and then a station somewhere in the back blocks having a telephone attached hearing a conversation going on, would call out and ask who was speaking, and on Sydney answering and asking who was there, would reply "Menangle" (40 miles from Sydney), or "Tamworth" (280 miles from Sydney), "Penrith" (34 miles), "Junee" (99 miles), &c. Penrith on the Western line not only heard the taking, but in one instance recognised and called by name one of the speakers with whom he was acquainted. The day was not the best of days for the experiment, as nearly all along the line a fine driving drizzle was falling; wet and misty weather being reported not only at each end but in most places on the route. The experiments were instituted by Mr. E. C. Cracknell, superintendent of the New South Wales Telegraph Department, and carried out under his directions by Mr. J. Y. Nelson, A.I.E.E., electrician to the department; the arrangements at the Melbourne end being carried out by Mr. H. W. Janvey, A.I.E.E., electrician of the Victorian Government Telegraph Department.

REVERSAL OF POLARITY IN PLATING DYNAMOS.*

By HARRIS J. RYAN.

SHUNT machines used for copper-plating carbons are frequently found to have their polarity reversed after being stopped. The cause can be ascribed only to voltaic action of the unplated or partially plated carbons, copper anodes, and the plating solution. Any electromotive forces in the bath that would result from the electrolytic action of the dynamo current must be counter to the E.M.F. of the dynamo. Any current that these counter E.M.Fs. might set up through the dynamo when at rest, as is well known, could tend to only maintain the same polarity.

To determine the extent of the voltaic action, Messrs. Thayer and Warner, of the senior class in electrical engineering at Cornell, made a copper plating bath of the density that is found to do best for copper voltameter work. This solution was increased 20 per cent. by the addition of commercial sulphuric acid, so as to obtain a solution practically the same as that used by the carbon platers for good tough deposits.

Time.		Volts.		Remarks.
11.20	...	− ·170	...	Carbon unplated.
11.20½	...	− ·004	...	Current on 30 seconds. Lower part of carbon plated; plating on the upper part scarcely perceptible.
11.28	...	− ·012	...	
11.30	...	− ·138	...	
11.32	...	+ ·085	...	Current on 1 minute. Well-marked deposit on carbon.
11.34	...	·000		
11.36	...	− ·002		
11.40	...	− ·064		
11.48	...	− ·130		
11.50	...	+ ·064	...	Current on 5 seconds.
11.52	...	− ·124		
12.15	...	+ ·138	...	Current on 13 minutes.
12.20	...	+ ·064		
12.36	...	+ ·053		
12.55	...	+ ·021		
1.45	...	+ ·006		

\+ Indicates a counter E.M.F.
− Indicates a voltaic E.M.F.

The table explains itself, and shows that the difference of potential between the unplated carbon and copper is ·17 of a volt. After the deposit of a thin film of copper on the carbon, this E.M.F., which immediately after stopping the current was ·004 volt, was raised, so that at the end of 10 minutes, it was ·138 volt. When a marked deposit was made by the application of the electrolytic current for one minute, the cell gave a counter E.M.F. of ·085 of a volt immediately on stopping the current. The return of the voltaic E.M.F. was evident, for two minutes later the E.M.F. of the cell was zero, and 16 minutes from the time of stopping the current, the voltaic E.M.F. of the cell was ·130 of a volt. At this point the application of the current for but five seconds produced a momentary return of the counter E.M.F. of the cell. Even after the carbons had been well plated by the application of the electrolytic current for 15 minutes, when the counter E.M.F. of the cell at the moment of breaking the circuit was ·138 volt, there was a strong tendency manifested for the return of the voltaic E.M.F.

It is seen, therefore, that with a shunt electro-plating machine at work on a bath for plating carbons, there is danger of reversing its magnetism whenever it is stopped before the carbons are well coated. It may be avoided by breaking the main circuit before shutting down, and making it again only after the machine has been brought to full speed. This method would generally require the use of a large and expensive knife switch. Breaking and making the field circuit in the same manner would do just as well.

* A paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, Ill., June 6th, 7th, and 8th.

READING IN RAILWAY CARRIAGES.

THOUGH the question of providing a greater amount of light in railway carriages has for years past occupied the attention of railway managers, the illumination is, in most cases, no more than is required to enable the passenger to enter and leave the train in safety, while the possibility of reading in comfort is still out of the question.

To the Metropolitan District Railway Company belongs the credit of being the first to adopt a system of electric lighting which gives the travelling public just what is wanted, and at the same time admits of a satisfactory profit being made by the company undertaking the supply. This want is met by the railway electric reading lamp, which is a machine invented by Mr. Tourtel for retailing electric light to passengers by pennyworths.

A few of these lamps have been experimentally in use on the Metropolitan District Railway for the past two years, and the results of the trials have been so satisfactory, that a contract has been made by that company with the Railway Electric Reading Lamp Company, of No. 1, Great Winchester Street, E.C., to instal up to 10,000 reading lamps in the carriages of the District Railway, and we understand that similar contracts are being negotiated with other railway companies.

It is not intended at present to displace the gas lamps in use in the roofs of carriages, but to provide a separate light for passengers desiring to read.

The mechanism of the lamp is exceedingly simple, and is contained in a box 5 inches by 3 inches. Upon introducing a penny into the slot at the top of the machine, and subsequently pressing a knob, an electric light is obtained which burns for about half-an-hour, at the end of which time it is automatically extinguished, but can be re-lighted by the insertion of another penny. The light, which is of about three candle-power, is concentrated by a shaded reflector, which may be turned within certain limits, so that the light may be directed to suit the position of the passenger. One of the most remarkable features of the instrument is its honesty, as it is so arranged, that in the case of a failure in the supply of electricity, the machine automatically returns the coin to the operator. Another noticeable feature is that, should the lock of the apparatus be tampered with, a bell is automatically set ringing in the guard's van.

It is proposed to place these lamps under the hat rails in railway carriages, so that the passengers seated in the corners, and thus furthest from the roof light, may be able to provide themselves with additional illumination. The whole of the lamps placed in one carriage are supplied with the electric current from an accumulator placed under one of the seats of the carriage, which is thus entirely self-contained, and capable of being detached from the train without the light being affected. The accumulators can be easily changed, and will be replenished at charging stations near the terminus.

It is intended that four lamps shall be fixed in each compartment, which makes from 16 to 20 lamps in each carriage; and all these lamps will be connected in parallel circuit with the accumulator. The mains will be run in grooved boxing underneath that portion of the carriage which overhangs the longitudinal girders. Feed branches will be run from the mains through the floor of each compartment, and, from these feeders, branch wires will be carried beneath the lining of the carriage to each lamp, fuses being placed at each lamp and at the connection of the mains with the accumulator. The lamps are worked at the low pressure of 12 volts, and consume about three-fourths of an ampère. With this exceptionally low pressure, there is absolutely no danger of any kind.

The accumulator battery has been specially designed for the work, and consists of six cells, coupled in series, having a capacity of 72 ampère-hours. The cells are enclosed in a strong wooden case, which is provided with rollers and handles for convenience in removal, and duplicate sets of accumulators are provided for each train.

The charging current will be about 30 ampères (*i.e.*, 10 ampères through each set), at a pressure of about 100 volts, while the power required will be only from 16 to 20 horse-power.

An authority upon electrical matters, as affecting railway companies, Mr. C. E. Spagnoletti, Past President of the Institution of Electrical Engineers, and consulting electrician to the Great Western Railway Company, points out the following, among other conveniences, which this system offers to travellers:—A good steady light to read by; a light always at hand, and ready for use; no forethought required to provide lamp or candle (so often forgotten) before starting on a journey. This lamp enables the traveller to recline in any position and direct the light as desired, whereas with a roof lamp an upright position is necessary to get the light on the book or paper. Travellers are able to obtain a good light for reading without interfering with others who require less light and to sleep. Each carriage being independently lighted these lamps will not be extinguished by severance of the train at junctions, when changing engines, or when taking off or putting on vehicles. A carriage can run over various railway companies' systems as a through coach, and these lamps will not be affected.

The Proposed Electric Lighting of Hertford.—Now that the Corporation have obtained an electric lighting order the Mayor has just sent a circular letter to the principal inhabitants, for the purpose of ascertaining the number of intending users of the electric light.

A FEW HINTS TO DYNAMO TENDERS.

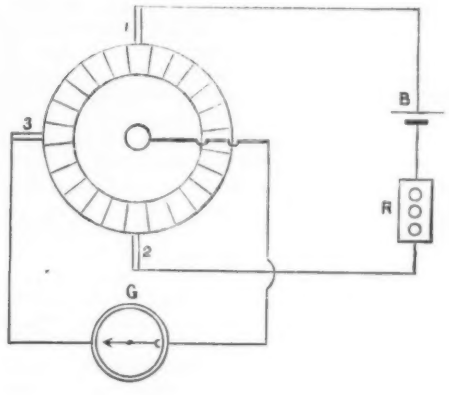
THE dynamo man is oftentimes not burdened with too much theory, and even if he be *technically* educated, he has been so accustomed to use elaborate testing instruments that he is more or less at sea when only a voltmeter and ammeter are available for measuring and locating an earth, &c. Mr. Foree Bain, sympathising with these difficulties, has contributed to the *Western Electrician* a few useful hints, which will assist the dynamo man to "locate niggers." The methods are not new, but they are given in a clear and practical way, and we think them worth reprinting for student readers.

(*a*) To measure the insulation resistance of a dynamo with a voltmeter of which the resistance is known. (By-the-bye, makers should always mark the resistance of instruments in some conspicuous place, ready for easy reference.) Let this voltmeter resistance be R, and when the dynamo gives its normal E.M.F., let the deflection in the voltmeter be D volts. Now connect one terminal of the voltmeter to the positive brush and the other to the shaft, and note the deflection, *d*. The insulation resistance of the dynamo will be found from the formula—

$$\text{Insulation resistance} = \frac{\text{D R}}{d} - \text{R ohms.}$$

The insulation of the field coils, brush holders and armature can be separately measured by suitably arranging the connections.

(*b*) To find a coil *earthed* to the frame of an armature See fig., which clearly shows the arrangement of the



details. B is a battery, or dynamo circuit, giving a current of a few ampères through the armature by its own brushes, 1 and 2. At *a*, a roughly made galvanometer to carry some 25 ampères, or so, is placed, one terminal being in connection with the shaft of the armature, and the other attached to a movable brush, 3. Since the function of the particular galvanometer is simply to show a deflection when a current is passing and to mark zero when there is none, a coil of thick wire, with a pocket compass in the centre, will do all that is required, but care must be taken to remove it sufficiently far away from the disturbing effects of the armature magnetism. The manner of testing is as follows: Assume a steady current to be flowing from B through the armature, touch the commutator with brush 3, and a current will flow through *a*. Slowly rotate the armature or the brush 3, until the galvanometer, *a*, shows no deflection. The coil in connection with the segment in contact with 3 will be found to be *earthed*.

(*c*) To find a short-circuited coil in an armature. Adopt the same device as shown in fig. 1; but couple two brushes, 3 and 4, to the terminals of the galvanometer. Fix one of these, and then find a position for the other in which no current flows in *a*. Count the segments on either side of the commutator between brushes 3 and 4. That side which has the greatest number contains the short-circuited coil or coils. By a few trials the damaged coil can be located beneath one of the brushes, and its position confirmed by

putting brushes 3 and 4 on adjacent segments and marking, when no deflection is shown by the galvanometer. This latter confirmatory test is only possible with a fairly sensitive arrangement of coil and needle; but it is surprising what excellent tests can be made with rough instruments if the operators know how to use them, and to gauge the observations made.

The main advantage of both of these tests is, that the damaged coil can be located without unsoldering the commutator, which is sometimes a difficult operation without proper tools; and, further, the fault can oftentimes be repaired without disconnecting any of the wires if its exact position be determined.

THE EICKEMEYER-FIELD MANUFACTURING COMPANY.

THE *Electrical Review* of New York contains a brief sketch of the development of the dynamos and motors known by the name of Eickemeyer. These machines seem likely to make their mark in electric railway work, if the reports from Yonkers and Boston are to be credited. Our readers will recollect that the Eickemeyer motor is of the armour-clad type, with a drum armature, and the windings of both the field and armature are different from those of any other machines now in the market. We have always had strong doubts as to the efficacy of the arrangement, and are still of opinion that equally good results can be obtained with the normal type of winding. However, it seems that these motors have been very successfully applied to both single and bogie truck cars, and the inventors are sanguine of success "with locomotives of a size hitherto unattempted." The principle of coupling the armature to the four wheels is mechanically perfect, and if the curious winding of the drum armatures will stand the vibration, as the manufacturers say they will, there should be a large future before them. The motor is carried by cushioned seats on the two rolling axles; the armature shaft carries a crank disc, which is coupled through connecting rods, with swivelled brasses, to pins in the rolling wheels. The design admits of 26-inch car wheels, and so the body is much lower than is usually the case. Cars thus equipped have been worked successfully on grades of 11¼ per cent., and in Yonkers trailing cars are hauled over a grade of 7 per cent., which is 1,000 feet long.

A powerful slow-speed motor coupled to the four wheels of the bogie or truck certainly seems to be an advance on the two high-speed motors usually employed for the same work. It remains to be seen, however, if the gross average efficiency is so satisfactory. The real test is the amount of the coal bill, cost of renewals, and the number of stoppages; and time alone can give the commercial value of the various systems. The Eickemeyer-Field Company at any rate have developed a new departure in tramway work, and we wish them success. The motors are extensively used for driving Otis lifts, and also for general purposes.

A CENTURY OF GAS-LIGHTING. THE "MONOPOLISTS" CONSOLE THEMSELVES.

THE Murdoch lecture delivered a few weeks ago before the Incorporated Gas Institute by Prof. Vivian B. Lewes, and entitled "A Century of Work on the Development of Light from Coal-Gas," was an admirable, and, on the whole, temperate *resumé* of the more important advances made in the industry of gas lighting during the period named. Those who can read between the lines, however, will be gratified to find that our "rival interests" are exhibiting a leaning towards what we have often urged to be their true and future function, namely, the utilisation of coal-gas as a fuel.

Prof. Lewes, we presume, is acting as the mouthpiece of the "great monopoly" when he complains that the development of the gas industry has been kept back, more than anything else, by the fixing of the illuminating value at too high a figure. "If," he says, "a 14-candle standard had been adopted here in London instead of a 16, an almost unbearable burden would have been taken off the gas manager's shoulders, and not one consumer in a thousand would have noticed any difference in the light; indeed, a little trouble on the part of the companies in advising consumers as to the best forms of burner to use would probably have resulted in an absolute gain, whilst the reduction in price consequent on the doing away with need of enrichment would have given an enormous impetus to the use of gas as a domestic fuel."

The latter part of this statement we thoroughly agree with, but really we fail to understand the mental (we had almost written *moral*) attitude which is implied in the former portion. What is this *development* that the professor wants? If he is referring to the further inflation of already bloated dividends, then it is clear enough, and the allusion to it would not be indelicate before a meeting of the Incorporated Gas Institute. But if he wants to lower the price per thousand in order that more of it may be consumed, then he is canvassing a want which everyone feels who uses gas either for domestic heating purposes or for driving gas engines. If, however, the gas companies plead for a low standard of illumination, we are content to let them, for we know they are pleading our own cause, and that it will only hasten the coming of that inevitable time when the general illumination shall be performed by electricity, and gas shall be relegated to the function of supplying heat-energy.

This enlightened time must, according to the showing of Prof. Lewes, be yet a long way off. He titillated the feelings of the assembled gas-managers, directors, &c., with some very soothing statistics which were designed to show how vastly more expensive illumination is by electricity than by gas, light for light. We all know that in the hands of skilful people statistics can be made to prove anything; but we must never enquire too closely into the source of such obliging data, although in this case we regret that we cannot discover any error. We therefore print the statistics as he gave them, merely stating that the first and last of his figures agree with what we have ourselves always stated:—

Annual Cost of Maintaining a Light of 48 *Candle-power, say,* 2,000 *Hours burning.*

RESULTS OF TESTS UNDER PRACTICAL CONDITIONS.

Gas—"Argand"	3 16-candle lamps, consuming each 5 feet of gas per hour.	30,000 cubic feet of gas, at 3/- per thousand.	90/-	93/-
		Renewals of chimneys	3/-	
„ Regenerative burner ...	1 small lamp, consuming 6 feet per hour.	12,000 cubic feet of gas	36/-	41/-
		Repair of lamp, &c.	5/-	
„ "Albo-carbon"	2 No. 2 "Bray" burners, consuming each 3½ feet per hour, carburetted with naphthalene.	14,000 cubic feet of gas	42/-	55/-
		52 lbs. naphthalene, at 3d.	13/-	
„ Incandescent	1 new large mantle, 48 candle-power, burning 3½ feet per hour.	7,000 cubic feet of gas	21/-	30/-
		Renewals of mantles, 3 at 2s. 6d. ...	7/6	
		„ „ chimneys	1/6	
Petroleum—Large lamp ...	1 48-candle lamp, burning 1 gallon in 28 hours.	Oil consumed, at 7d. per gallon	41/8	44/-
		Chimneys, wicks, &c.	2/4	
„ Small lamps ...	4 12-candle lamps, each burning 1 gallon in 84 hours.	Oil consumed	55/6	58/-
		Chimneys, wicks, &c.	2/6	
Electric—Incandescent ...	3 16-candle lamps, absorbing each 56 "watts."	Cost of current at 8d. per Board of Trade unit (1,000 watt-hours).	224/-	245/-
		Lamp renewals, 6 at 3s. 6d.	21/-	

These data appear to be due to Prof. Lambert, whom Prof. Lewes describes as "a colleague of mine at the Royal Naval College, who has been for some time past experimenting in his own house as to the cost of various forms of illumination on a domestic scale." But, after all, what does it matter under what conditions the experiments were made, so long as everybody was pleased?

Harking back to the subject of the utilisation of coal gas for heating purposes, there are some who would deprive the gas companies of even this field of enterprise. It is surprising how much scientific men and experts, who are disinterested in either gas or electricity, are continually advocating the claims of the latter to popular favour. Perhaps the latest instance of this may be found in the speech delivered by Mr. A. E. Fletcher, Government Inspector of Factories, at the British Association meeting on August 9th, during the discussion of Dr. Bailey's paper on "The Impurities of Town Air." He expressed his opinion that great things would be done in the way of air purification when electric heating is developed. The gas monopolists may "chortle" over what to their minds may seem an almost impossible eventuality as much as they please; but let them wait till the electric light can show a "century of work;" by that time we doubt not that there will be applications of electricity of a more remarkable nature than the warming of factories.

WATER POWER.

BY E. TREMLETT CARTER.

(*Continued from page* 224).

II.

11. *Open Conduits.*—The construction of artificial waterways, whether in the form of open channels or closed pipes, for the purpose of leading the water to and away from the engine, is a matter of some importance. Water wheels are usually supplied with water from open channels, while the conduits leading to turbines are closed at the engine end, though often open for some distance beyond the point where they join the stream. There are three principal open conduits in a mill plant; the *head-race*, or conduit leading from the stream to the engine; the *bye-wash*, leading from the head race to the bottom of the weir and acting as a waste channel; and the *tail-race*, or conduit leading from the engine to the lower part of the stream. An enlargement of the head race at the engine is called the *penstock*; and this race is often also enlarged so as to comprise the *pond*. A general plan of these and other mill details is given in fig. 6.

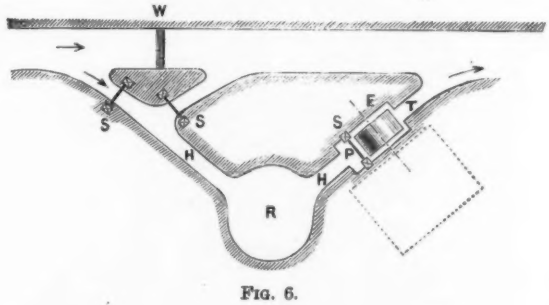


FIG. 6.

The head race, H, enlarges into the pond at R, and into the penstock at P. It terminates in a sluice, S, through which the water passes to the guides to the engine, E, and from this latter to the tail-race, T. The bye-wash, with its sluice weir is shown at B, the overfall weir being at W. It will be observed that the junction of two channels is always well rounded off, so that there is no loss of head or wear of the banks through the eddying which would be caused by sudden contraction of the stream. This is a very important item in the design of water-ways. The diagram illustrates a mill on a straight piece of water; but a less expensive plant is involved if the mill site is on a bend in the stream.

Open conduits are designed with respect to two considerations: durability and loss of head. The prime cost of the construction must be set off against the annual depreciation which will result from the wash of the water, which latter increases as the former is diminished; and is further set off against the fall of level in the races, and the consequent reduction of the available head, which friction in the conduits involves. Thus, to build a narrow and shallow channel, with the view to prime cost economy, will necessitate a large annual outlay in repairs, and will reduce the efficiency of the mill site. While to build a very large conduit would involve a prime outlay which would not be justified by the increased economy in working costs. It must be observed that the actual value of these considerations will depend on the nature of the materials employed, as well as on the cost of labour for erecting the plant. Neglecting the latter, as being beyond discussion in a series of papers of this character, we find that the section of the race will be increased in proportion as the material forming its bed is liable to be washed away by the current. Where a light soil is uncovered with cement or an artificial layer of clay, the channel must be made much larger in section than where these materials are used; or again, where there is a natural bed of granitic or other unstratified rock, a much smaller race will suffice than with, say, sandstones or chalky strata. Weisbach gives the following as the maximum allowable velocities of the current over beds of various materials:—

Material.	Feet per second.
Mud	0·25
Clay	0·50
Sand	1·00
Gravel	2·00
Loose stones	4·00
Slate or shale	5·00
Stratified rock ...	6·00
Unstratified rock ...	10·00

Where the race is constructed of slabs of stone or of brickwork, a velocity of five feet per second is usually allowed.

The friction of an open conduit is proportional to the length of the conduit, to the perimeter of the wetted section, and to the square of the velocity of the current in contact with the bed; and is inversely proportional to the sectional area of the stream. It is measured in feet of loss of head; thus

$$\text{Loss of head} = k \cdot \frac{l \cdot p}{A} \cdot \frac{v^2}{2g} \ldots \text{feet}$$

where k is a constant depending on the material of the conduit and the velocity of the stream. Its value for all common materials is approximately 0·007565.

The ratio of the sectional area of the stream to the perimeter of the wetted section is called the "hydraulic mean depth" of the stream, and should be large if the loss of head is to be small.

Besides the friction which is thus caused by the rubbing of the water against the bed, there is also a certain amount of internal friction in the stream, due to the fact that all parts of the section are not moving with the same velocity. This also causes a loss of head, and is chiefly of importance at bends or sudden alterations of section of the channel. To avoid the wasteful eddies set up when a stream is caused to suddenly change its direction or velocity of motion, all bends should be very gradual, with a radius of curvature of never less than 6 times, and usually 10 times, the width of the stream; and all changes of section should be avoided except where it is absolutely necessary to have them. The loss of head must also be kept low by making the head and tail-races as short as possible; to this, however, there is a very reasonable exception, as will be seen in the section on turbine races.

The best shape of section will be that which, for equal expense, gives the largest value for the hydraulic mean depth. Any section, the sides of which are tangents to a common circle, the centre of which is on the surface of the stream, will have the maximum value of this depth. Sections which fulfil this condition, and which are very frequently used for races, are shown in fig. 7. Of these the semi-circular

is the most expensive, and the rectangular the least expensive and most common. If the level rises or falls the H.M.D. changes and the friction increases. It is possible to design a section which will have the same value for the H.M.D., whatever the flow of water; but the actual construction of this on a mill site would be expensive. The value of the H.M.D. for all sections in fig. 7, is one-quarter of the diameter of the circle.

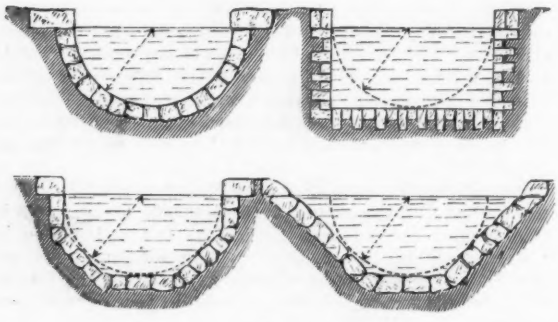


FIG. 7.

Water ways for small mills are often constructed by merely digging out a trench in the natural soil, no artificial protection against filtration or washing being provided. In this case it is often impossible to have a very large H.M.D., owing to the fact that the sides cannot be made steep enough. A common trench for this purpose, which is used where the soil is gravelly or composed of loose stones, is shown in

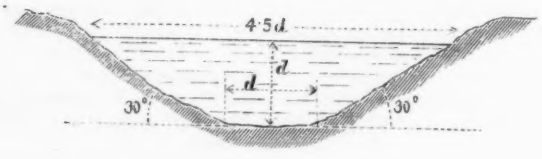


FIG. 8.

fig. 8. The value of the H.M.D. is three-fifths of the depth at the centre, and the maximum width of the stream—though that of the trench will be greater—is about $4\frac{1}{2}$ times the depth at that place. This trench, therefore, takes up a lot of ground.

12. *Closed Conduits.*—A covered or filled conduit possesses many advantages over an open trough. By means of it, water can be conveyed in any direction with an unaltered velocity and with no risk of overflow. In an open conduit, if the declivity of the stream is greater than the loss due to friction an increase of velocity of the water ensues; while stoppage of the outlet risks flooding. A steep open race must, therefore, be regulated from the top. But a closed pipe may be placed so as to convey the water vertically downwards or vertically upwards, or in any other direction with no change of velocity, and may be regulated at the bottom; for when the sluice is closed the pipe remains filled with water at a slightly greater pressure. Again, a closed conduit protects the water from the flotsam and jetsam which the trees and soils richly contribute to an open stream; and this is of immense advantage to the engine. Lastly, whenever the engine is to be worked partially or entirely by the pressure of water, the head must be produced by means of a column of water in an enclosed and filled conduit; an open conduit is quite useless for this purpose.

Hydraulic pipes are circular in section. They are of cast iron, when of small size, and of riveted plate or sheet wrought iron or mild steel, when of a larger diameter than about one foot. The stresses to which the material of a pipe is subjected are the internal pressure of the water—which is a dead load during ordinary work, but an impulsive load when first applied—the bending caused by irregular setting in the soil or shifting of the soil after setting, and the expansion and contraction due to changes of temperature. The steady internal pressure is a maximum when the water is not in motion, though it momentarily exceeds this value when the motion of the water is checked, causing a serious shock in the pipe. The pressure per square foot due to a head of water, is independent of the section of the column and of the length of the pipe, and varies only with the vertical distance between the point where the pressure is measured and the surface of the water. This pressure is equal in all directions, at the same level. Calling p the pressure per square inch of surface, we have,

$$p = \frac{62{\cdot}4\ \text{H}}{144}$$

This causes a stress per square inch of the material equal to

$$f = \frac{p\,d}{2\,t} = \frac{62{\cdot}4\ \text{H} \,.\, d}{288\,t}$$

And, since this stress must not exceed the ratio of the ultimate strength of the material to the factor of safety used, the thickness must be at least equal to

$$t = 0{\cdot}217\ k \,.\, \frac{\text{H} \,.\, d}{\text{F}}$$

Where t and d are the thickness and diameter in inches, and F is the ultimate strength in lbs. per square inch. The factor of safety, k, must be very large to allow for the other stresses which have not been taken into account in the calculations. The usual values are given in the following table.

FACTORS OF SAFETY FOR HYDRAULIC PIPES.

Small cast iron, cast vertically	10
Large " " "	15
Wrought iron or mild steel (single riveted)	8
" " " (double riveted)	6

In addition to a high value for k it is usual to add a quarter of an inch to the calculated thickness in the case of cast pipes, to allow for imperfections in casting, &c. Wherever practicable, built-up pipes should be riveted with countersunk-headed rivets, the sunk heads being on the water side. Riveting is done with cold rivets, the same rules as for ship riveting being usually followed. The longitudinal seams are butt jointed, with one outside cover-strap, and the transverse seams are lapped. Small pipes are usually cast in 9 feet lengths, and jointed as shown in fig. 9.

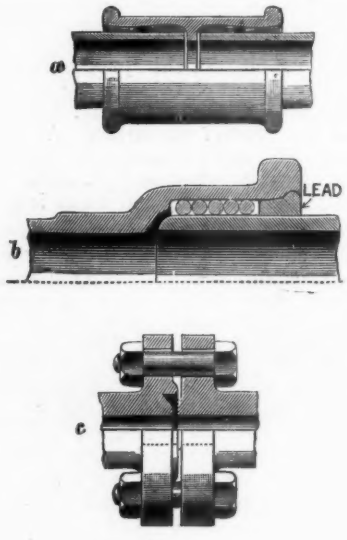


FIG. 9.

The object of the joint will generally be to secure strength, tightness and flexibility; a is known as the Kimberley joint, and consists of a cast-iron sleeve loosely fitting the ends of the pipes and packed with India rubber rings and red lead cement; b is a socket joint, packed with a few turns of tarred rope and an outer ring of cast lead, the lead being tightly stemmed into the joint with a tool; c is a flange joint, which possesses greater strength but less flexibility than the former examples: it is packed with a gutta-percha ring at the abutment of the two pipes.

Air relief valves should be placed at every point where air

is liable to accumulate; thus, at the top of a rising bend in the pipe. These are better if automatic in their action, opening when the air has accumulated to a certain amount, and closing when it has escaped, but are sometimes mere hand taps, which, if neglected, may cause serious trouble.

The frictional loss of head in a closed conduit follows the same law as for open troughs, and is independent of the pressure of the water. The H.M.D. of a filled circular pipe is equal to one-quarter of its diameter; and the velocity of the stream is equal to the ratio of the volume of water passing per second to the sectional area of the pipe. From these considerations we find that the loss of head due to a straight filled pipe is

$$h = k \cdot \frac{4\,l}{d} \cdot \frac{v_m^2}{2\,g} = k \cdot \frac{Q^2 \cdot l}{\pi^2 d^5} \text{ feet.}$$

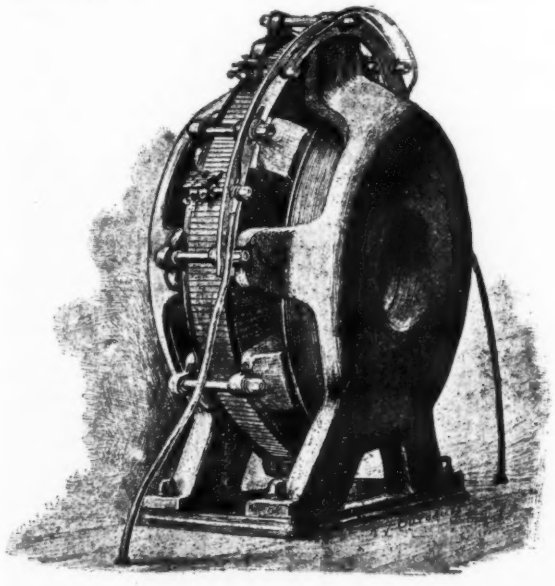
Pipes of different diameters conveying water at the same speed oppose a frictional loss of head which varies inversely as their diameters, or conveying the same quantity of water in a given time, oppose a friction loss of head which varies inversely as the *fifth power* of their diameters. The importance of large conduits where economy of head is of importance is thus evident. At bends a further loss of head occurs, for the reasons explained in the previous section; and the same rules should be applied as to open conduits. Weisbach gives the following expression for the loss of head due to a bend

$$h = \frac{v_m^2}{2\,g} \left\{ 0{\cdot}131 + 1{\cdot}847 \left(\frac{d}{2\,r} \right)^{\frac{7}{2}} \right\} \frac{\phi}{\pi};$$

where ϕ is the angle and r is the radius of curvature of the bend, and d is the diameter of the pipe.

THE LUNDELL DYNAMO.

THIS dynamo is the design of an American, and is running in one of the Edison stations in New York. It is a multipolar dynamo with a disc armature, the armature winding is a zig-zag winding, practically the same as that employed in this country by Mr. Kapp and others on drum windings for large multipolar dynamos. In this machine there are eight fields excited by only two coils; it may be classed as an ironclad dynamo.



Like some of the larger machines shown at Frankfort Exhibition, the outer peripheral windings form the commutator bars, and two pair of brushes only are necessary.

This same winding has also been used by Schuckert of Nuremberg for multipolar dynamo armatures; in his case the armatures are drums and a separate commutator is employed; the disc form having an open outer periphery, is better suited for working with the brushes directly applied.

The field magnets are ironclad, and excited by a circular coil, all the N poles passing over the outside, and all the S poles radiating from an inner core; this design gives a good stiff framework and makes a cheap efficient magnet. It, however, has not the advantages of some other ironclad magnets of the same class, wherein the N poles are all on one side and the S poles all on the other, thus saving all leakage of magnetic lines.

The machine is intended for slow speed direct coupling to engine, a practice not hitherto followed to any extent in America, where in most stations a high-speed engine is usually found belted to a higher speed dynamo. In this respect, alone, this dynamo is a decided improvement; direct coupling of dynamos to moderately speeded engines has long been recognised here and on the continent as the best practice; in some cases gas engines have been coupled directly to the dynamos.

The advantages of direct coupling are very great in central station work; less space is required, less danger exists, the power wasted by a belt drive is always considerable, and all belts require some attention, and often renewal. Against this, of course, must be placed the increased cost of a slow-speed dynamo over that of a quick speed belt-driven dynamo.

In this dynamo the cost of field magnets must be small, the whole being formed of four parts of cast iron, of a form easily machined and fitted together, forming, at same time, a good framework, while the field winding is of simplest possible kind. As to the armature, it is large, but of a construction not very elaborate, and forms a fly-wheel for the driving engine.

In America, as in this country, the tendency towards multipolar machines for large outputs is becoming more and more evident.

We have taken the illustration of this machine from the New York *Electrical World*.

ELECTRIC MINING AT BLEIBERG.

[FROM OUR OWN CORRESPONDENT.]

Discourse delivered by Herr Makuc, Director of Works, at the General and Itinerant Meeting of the Mining and Metallurgical Association of Styria and Carinthia, at Leoben, August 7th, 1892.

GENTLEMEN: You are probably aware that the greatest part of the extension of the adits is effected in our mine by means of the electric transfer of power, and that the installation which has been supplied by Ganz & Co., of Budapest, has since acted to our fullest satisfaction, and has brought us considerable advantages in mining. Hence it deserves to be brought forward and discussed in your circle.

I venture, therefore, to describe to you the installation, and the manner of its working, premising a few words on the conditions prevailing in our Rudolph shaft.

On this shaft, which has to supply 300,000 quintals yearly, depend the original adit, 1,600 metres in length, into which open several lateral adits, the most important of which, at the depth of 152 and 387 metres in the shaft, have the respective lengths of 270 and 722 metres. The electric despatch was preliminarily arranged for these three adits.

Our trucks have a gross weight of 7·6 quintals, their own weight being 2 quintals, and the work is distributed over 180—200 days in the year. The maximum work may amount to 300 trucks daily, which has hitherto been effected by men.

The inducement to the arrangement of electrical despatch was presented by the circumstance that the turbine, the capacity of which at the lowest level of the water is 30 H.P., was not fully utilised. The central work demands at the busiest time from 20 to 24 H.P., whence work = 6 H.P. can be thrown upon the turbine. The central preparing work is at a horizontal distance of 95 metres from the shaft. The depth of the shaft to the adit is 160 metres.

There were previously in our adits very weak rails, weighing 4·5 kilos. As they were nearly worn out, and as a part of the the track had to be carried over water, it was necessary to

change the material of the line and to lay down rails of 7 kilos. in weight, with supports at the distance of every metre. The crossings were formerly effected with cast-iron plates, and the curves were rather sharp.

The renewal of the materials gave an opportunity to adjust the curves to a radius of 20 metres, and a cheap and simple change of points was arranged at all crossings.

Both the shaft and the adits were very wet, and special arrangements had to be made in the leads for the current in order to prevent it from being carried away by wet.

The section of the adits is small, and only 700 millimetres could be admitted at the extreme breadth in the construction of the motor car, and 1,700 millimetres height for the arrangement of the leads.

If I further mention that the gauge of the trucks is only 430 mm., and cannot be reduced, since an alteration of the trucks is out of the question, it appears that the introduction of electric traction was attended with manifold difficulties.

In the spring of last year we had the lighting of our central preparing station executed by Ganz & Co., and the same turbine used for actuating the light-machine has now undertaken the working of the line. The slight demand for power in the lighting is included in the 24 H.P. consumed.

The illuminative installation was executed to our complete satisfaction, which induced us to invite the firm Ganz & Co. to arrange the electric works for the mine.

The project was based upon the maximum quantity to be forwarded, and upon a speed of 3 metres per second, *i.e.*, about 11 kilometres hourly. As the mean distance may be assumed as 1,300 metres, and the mean duration of a journey as 7 minutes, we may allow 20 minutes for the journey and return, together with the stoppages. If, as it has actually been done, the transmission is to be carried out with *one* locomotive, it must be able to draw a train of 5 loaded trucks.

We have, therefore, including the weight of the locomotive, to deal with 5·3 tons to be drawn. The line is partly horizontal, partly slightly inclining towards the shaft. The traction resistance, in view of the circumstance that the rails are always besmeared with clay, is assumed at 10 kilos per ton, and the locomotive must therefore be built for an effective capacity of 160 kilos, at the axles. Including the degree of efficiency of the electro-motor and the useful effect of the driving mechanism, a demand for energy of about 2,000 watts must be provided for.

This energy is conveyed by means of copper and silicon-bronze wires, the dimensions of which are calculated so that during normal traffic, not more than 5 per cent. loss of tension can occur. The loss of tension exceeds this theoretical limit only at the moment of starting the locomotive, as it then absorbs two or three times the normal quantity of current, partly to overcome the inertia of the train, and partly from electrical causes. But even at the moment of starting, the loss of tension must not be too great, because the same lead feeds the illuminative arrangement, and an abatement of the glow lamps in consequence of a great decline of tension must be avoided, because the locomotive carries glow lights by way of lamps, and the illumination of the distance traversed must be sufficient at starting.

In order to arrange the decline of tension with uniformity, the leads were connected, not at the shaft, but about at the middle of the distance traversed.

For illuminating the adits, eight glow lamps were installed, and including the losses in the conduction, a mean production of current of 2,500 watts had to be calculated on. But as the demand for current increases on starting the locomotive, a dynamo of 6,000 watts was set up as a generator.

This generator is a compound machine, which always produces a current of constant tension, without regard to the demand at the time. The regulation of the tension can be effected by means of a wire resistance, but it has been found that no resistance is needed, as the tension varies within such narrow limits that the efficacy of the lamps is not essentially affected. This machine is constructed for a tension of 220 volts, and at this tension, a contact of the conducting wires (which are everywhere left bare within the adits) is free from danger, and on incidental contacts, which are unavoidable in the narrow adits, occasions only a quite painless, tingling sensation.

The selection of the tension of 220 volts was determined by the energy to be transmitted, the length of the leads, the permissible loss of tension, and by the circumstance that we wished only to employ slender and, consequently, cheap wires for the working conductors, especially those wires on which the sliding contacts of the locomotive play, and from which the machine derives its immediate current. The conduction from the central station to the shaft-house is effected aboveground with an aerial conduction, supported on oaken pillars with porcelain bells. The conduction consists of two bright copper wires, 6 mm. in thickness. Before the insertion into the shaft building, a lightning conductor is introduced, consisting of two pairs of finely zinced plates mounted upon a porcelain stand and connected with the two wires above-mentioned in such a manner that a flash striking this conductor finds a short well-conductive way by springing over from one plate to the other into the earth.

I remark here, that in some severe storms the lightning has, in fact, struck the aerial lead and taken its way down into the earth without disturbing the mine. We are neither alarmed by a storm, nor do we find occasion to interrupt the transmission of ore. In the mine nothing is known of the mighty uproar of the elements which often rage above ground over our Dobratsch.

The conduction in the shaft must be laid with the utmost nicety, as it conveys a considerable quantity of water. It consists of two triple insulated copper wires of 30 square millimetres in section enclosed in a leaden sheath placed in wooden casings coated with a thick waterproof layer. The casings are held in position by porcelain bearers to which they hang by means of bells of wrought-iron. The two casings are conveyed in the transit division of the shaft, so that they may always be kept in view and their condition seen to.

The feed-leads are connected with the shaft conduction; the former of which consists of six bright copper wires 6 mm. in thickness, and are conveyed on special porcelain insulators along both sides of the main adit.

The supply of the working-lead is effected about the middle of the installation. The lead consists of wires of silicon bronze 6 mm. in thickness laid at the mutual distance of 330 mm., exactly above the middle of the track, and supported by suspenders, consisting each of two porcelain wedges, screwed to each other, and protected against the dropping of water by roofs of sheet zinc.

The wires are held fast to the wedges by plates of brass. The suspenders are hung to the walls by means of zinced wire-ropes at the height of 1,700 mm. with small porcelain insulators. The working conduction is thus doubly insulated from the earth and the rock, which was found necessary as the mountain, with its veins of lead, is a good conductor, and any defect in the insulation would involve a waste of current.

The choice of silicon bronze as material has its motive in the fact that this substance is at once hard and readily conductive; the wear and tear is very slight.

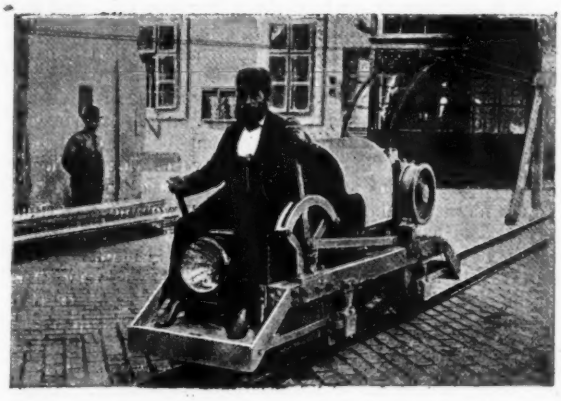
The crossing on to a side line is effected by a change of current, consisting of small carriages running upon flat irons, to which insulated wires are attached. These carriages can be displaced to the left or the right with the connected wire-loops in front of the rail conduction concerned, and can thus effect the conveyance of the current within the points.

Mention must now be made of the locomotives, the construction of which was not without difficulty, as it was necessary to build them narrow, low, and short, in order to avoid there being a great distance between the wheels.

The locomotive, the figure of which is appended, has two axles coupled together by means of Gall's chains, in order to utilise their entire weight as adhesive weight, which was necessary in order to travel upon the slippery rails with heavy trains. Experiments showed that three trucks can be drawn with the half weight of the locomotive, which weighs 1,550 kilos. For experiments we have dismounted the coupling chain, in order, if possible, to save its friction work. But as we connect five or six trucks in a single train, we have had to resume the use of the coupling chain.

One axle of the machine is driven with a second Gall chain by means of an intermediate pinion fixed on the frame of the machine, and directly actuated from the shaft of the electro-motor by means of a worm. Upon this shaft there is also keyed a brake-disc, over which lies a differential brake-band which can be attended to from the driver's seat. The brake is very efficient, and the train can be stopped within the distance of about 20 metres, in case of an unexpected obstruction in the adit.

The electro-motor is actuated by means of a lever placed on one side of the driver's seat, by which current is conveyed to the motor in one or other direction, so as to set it in motion in one or other direction. For regulating the speed, use is made of a rheostat placed underneath the driver's seat, and protected by a wooden chest.



The current is received by means of two curved arms, formed of wrought-iron pipes, which press like springs upwards against the working conduction. At their upper ends wrought-iron plates are fixed, insulated, which turn in their beds, and can apply themselves to the wires. By these sliding contacts the current is conveyed with insulated wires into the interior of the machine.

The locomotive is equipped with reflector lamps at its two front sides, in which there are glow lamps of 10 normal candles, which throw their light to a distance of more than 100 metres in advance, so that any obstacle may be perceived in good time and the changing points may be observed.

It may still be noticed that provision is made for abundant lubrication, and that the worm is enclosed in a case filled with oil. All the more sensitive parts of the machine, especially the electro-motor, are protected against dropping water with sheet-metal shields.

It is, finally, to be remarked that on setting the installation in action it was found that the insulations were everywhere very good and that the loss of tension in the leads was smaller than had been calculated on. The total consumption of current measured on an ammeter placed close to the primary machine varied from 12 to 20 ampères, and by these fluctuations we may judge how the driver manages the machine. On starting, the index of the current meter is found to shoot up to 20 ampères, whilst when driving smoothly the index always shows between 10 and 16 ampères. The mean consumption of energy, including the lighting of the mine and all losses by falling off of tension and defective insulation, is about 4 electric H.P.

Though not essential, it may be remarked that we light electrically not merely the place where the trucks are filled, but all the branches, every 2 16-candle lamps being introduced in series. The entire installation perfectly corresponds to our expectations.

THE RELATIVE VALUE OF EXHAUST STEAM.

By W. H. BOOTH.

My recent comments upon some remarks of Mr. Babcock in the New York *Electrical Engineer*, as to the value of exhaust steam, unfortunately fell upon that gentleman in a more than usually dyspeptic moment, and he replies in a column's length of abusive invective, commencing with a charge of self-satisfied ignorance against me, which I hope I can afford; and then on through a string of other charges to the conclusion that I have adopted dilution as a principle, and have, therefore, diluted my small amount of fact with a large supply of lies (fiction is the exact word he uses). While regretting that he did not dilute his large amount of abuse with even a little of the courtesy of ordinary debate, I do not see that my peppery friend has helped matters forward or advanced any engineering facts. Of course, as a steam engineer, I object to his statement that steam which has done work in a cylinder is a gas, and I consider his charge of fraud against my milkman as uncalled for as it is childish, for my house authority tells me he is a very decent fellow and not likely to be taken to task for the fraud indicated. The same authority also says, "that is the first letter from an engineer which I have seen dealing with the milk question." "Is Mr. Babcock a food inspector?"

Of course I wrote for Englishmen, and for the conditions met with in most English large towns, and need hardly say that the public water supply has all the necessary pressure to reach the top of the highest buildings, and my critic's gratuitous assumption of an outlay for engines, pumps, &c., to make it flow, is, I trust, simply due to his ideas of English water supply being on a par with those which possibly obtain at Lockport, N.Y., or, as they did obtain, in my day, in New York City.

In Halifax, for example, until the practice was put a stop to, steam boilers were fed direct from the town main. My system of water circulation, which is not my system in the way my critic tries to say I have claimed it, is certainly not the system he means, with circulating pumps.

If he will state to what extent the passing of a town water supply through a surface condenser will reduce its capacity to touch the highest floors, I shall be much obliged, as I have always thought a column of hot water was lighter than one of cold water.

The doubts, difficulties, and dangers which crowd before him so thickly that they also appear to him to envelop others, would quite disappear could Mr. Babcock acquire some really definite information upon English conditions, and differentiate them from conditions prevalent in America, as I hinted very plainly should be done. If my article deserved such a torrent of abuse, it deserved at least a more careful reading than was given, for I certainly never denied the advantage of selling waste heat as steam. What I did do, was to show that the selling of waste heat did not involve the abolition of the condenser, and I fear that in some way I have squeezed the Lockport critic on a patent corn, for his abuse contains nothing whatever of value in disproof of my suggestion to utilise English facilities for English purposes, and American facilities for American purposes. One thing is certain, the nuisance arising in Broadway from steam pipes would not be tolerated here. I would now inform Mr. Babcock that my system, as he is pleased to call it, has been very largely carried out in London to a modified degree, and I have no reason to believe is not still being carried out. The difference is one of degree, however, but some of the London water companies pass their water on its way to London through their condensers, and while obtaining a good vacuum, add very little to the temperature of the supply. They do not charge for the heat added, but the principle is there anyhow. "To circulate exhaust steam then" requires, we are told, 5 to 10 lbs. additional pressure, and it does not cost much to raise the pressure this trifle. Does it not? An additional 10 lbs. may cost a new set of boilers, for boilers do not last for ever, and a matter of 5 or 10 lbs. often does mean a good deal, especially with boilers difficult of access for cleaning, &c., and my contention as to the very little go left in ordinary exhaust steam is thus borne out. Certainly steam of 10 lbs. is not ordinary exhaust.

As regards the interjectory remark—fact against theory—in connection with Mr. Collins's excellent article, the success of any plan of disposing of waste heat is of no value whatever in disproving the superiority of other systems. No one doubts the excellent results achieved, for example, in old atmospheric pumping engines, but their success did not prevent the recognition of the superiority of Watt's "theory," but how often is it the case that the self-styled practical man, who is never so happy as when thus engaged, raises a bogey which he dubs theory, and proceeds to abolish it, seeing no good in anything but what has come within his own narrow horizon. Evidently Mr. Babcock, who does not, we may infer, lack aught of information, has no imagination, and when facts are wanting, will never theorise. For my own part I shall continue to theorise upon matters until they *have* been settled by facts based on experience, but I shall certainly not accept the dictum of Mr. Babcock as to what matters are settled as facts, and what are not so settled. Believe me, said an eminent statesman to two M.Ps., who were discussing his Cabinet's action, we are perfectly sincere. My lord, was the reply, it is not your sincerity we doubt; it is your capacity.

THE BARKING-CANNING TOWN ELECTRIC TRAMCARS.

In an esteemed contemporary last week, there appeared an article entitled, "Storage Traction Finance," in which were made some startling statements with reference to the action of the North Metropolitan Tramways Company in connection with the Barking accumulator tramcars. With this information before us, we referred the matter to the company's general manager, Mr. R. L. Adamson. This gentleman threw an entirely different light on the subject, and supported it by the correspondence between himself and the General Electric Power and Traction Company, which was running the cars. Now, the North Metropolitan Tramways Company have fully recognised the importance of electrically propelled tramcars, and have acquired parliamentary powers to work the whole of their lines electrically, and if it had not been for the opposition of the West Ham Corporation they were prepared to contract for twenty—or more—accumulator cars being put on the Leytonstone part of their system some two years ago. They have been and are ready to give opportunity for commercial trials to any bonâ fide company; and it is within the memory of our readers that the Elieson accumulator system, with trailing cars, was tried on the North Metropolitan lines at 4½d. per car mile, this sum determined by the electricians as a fair figure, being a little lower than the then cost of horse traction.

Nearly five years ago, Mr. Adamson informs us, the Electric Traction Company approached the tramway people, and offered to run cars at 3¾d. per car mile; but he, acting for the tramway company, and wishing to give the scheme every chance, offered the electrical company 4½d., the same figure that the Elieson Company had received. Accordingly, a contract between the parties was entered into.

The Barking-Canning Town section was selected because it was of convenient size for the proposed experiment, and since the traffic would only support five cars, the necessary capital outlay was not large, and consequently the experimenters had a fair opportunity of showing what they could do, without an undue expenditure, rather an important factor in this cause, when it is remembered that the Local Authority would not relinquish its power to stop the electric cars on 24 hours' notice.

We may point out that the electrical company entered into the contract, knowing full well that the line as constructed—single, with passing places—would not permit of an increase in the number of cars. And we think it important to note that the number of cars actually run electrically was rarely more than four, one or more horse cars being nearly always on the road. It is true that by special efforts the five electric cars were occasionally kept running during the last few months; but the reserves were either insufficient, or the difficulties met with in respect to the accumulators and other details, were such that the full mileage could not be maintained. These are facts borne out by the time sheets of the tramway company.

When the original agreement was made, it was distinctly understood that the Electrical Company should regularly furnish full particulars of the repairs and running charges to the Tramway Company, and that on the expiration of the term of the agreement the Tramway Company might exercise its option to take over the plant and work the cars themselves. Nevertheless, Mr. Adamson tells us that he never could get any statement of the running expenses, although repeated applications were made. At the end of the second years' agreement the electrical company offered to continue the contract, if an advance of 1d. per car mile were given, making a total of 5½d. As the price of forage had gone up since the date of the last agreement, the North Metropolitan Company, after due consideration, agreed to pay this amount for another 12 months, and this despite the fact that the repairs of cars and permanent way was about twice as great as with the horse service. The Tramway Company were led to this course, which involved a monetary loss to them, in the hope that the experimental difficulties would be overcome at an early date, and that both they and the tramcar world in general would ultimately be benefitted by the electric service. However, they were disappointed. Towards the end of April of this year, about a month before the third contract expired, they wrote to the electric company requesting information as to whether they wished to renew the agreement. The answer was that the directors of the General Electric Power and Traction Company could only enter into a fresh contract for 12 months if 7½d., was given, this being a rise of 2d. per car mile. This the Tramway Company declined. Sir Henry Mance, the secretary, and the engineer then in charge of the electric cars at Barking, waited on the Board of the Tramway Company and urged their views on the subject. The North Metropolitan Board went fully into the matter and said that an increase of 2d. per car mile would raise the cost of haulage far above that of horse traction, and that the electric cars were already costing them between £700 and £800 a year in excess of the horse charges for similar mileage; but still they did not wish to throw a wet blanket on the experiment and would consent to a further agreement for 12 months at 6½d. per car mile. This was accepted by the Electric Company, but from reasons not apparent was not signed.

In the meantime the General Electric Power and Traction Company had handed the control of the Barking cars to the Electric Power Storage Company, without consulting the tramway people in any way. It is needless to say that such an arrangement was considered as being distinctly a breach of the agreement between the two companies, and was in no way contemplated by the tramway people. Very soon, says Mr. Adamson, the irregularities in the traffic began to increase in number and importance. After repeated remonstrances from this gentleman, the General Electric Power and Traction Company wrote to him stating that the cars were now being controlled by Mr. Patchell, of the E.P.S. Company and they would be glad if he would accept him as their representative in case he found it necessary to call or write. During the latter part of June and the early part of July the new electrical management commenced a fresh batch of experiments, and soon the number of cars running electrically was reduced in consequence, amongst other causes, of broken axles. Now, by the terms of the agreement the Tramway Company furnished the axles on receipt of proper details as to sizes, &c.; and in this particular instance tracings of the details were not delivered with the requisition for new axles, and hence delay. We may point out that owing to the experimental nature of the plant, axles of several sizes were in use, so, on July 12th, Mr. Adamson wrote a letter to the Traction Company complaining that the electric cars had been running so badly during the past few weeks as to bring the whole service into discredit, and that in view of the work being no longer conducted by the General Electric Power and Traction Company, but having been transferred without the authority of the Board of the Tramway Company, &c., the directors declined to enter into any further agreement with them, and would take the earliest possible step to have the line worked as formerly by horses. On July 15th, Mr. Fuller and Mr. Immisch, directors of the General Electric Power and Traction Company, met the chairman of the Tramway Company, and requested three months' trial at 6½d., as they wished to demonstrate that the haulage could be made at that figure. This was fully considered by the directors of the North Metropolitan, but in view of the unsatisfactory result of the working during three years, and the fact that they were no nearer finding out the true cost of electric haulage, it was decided to refuse a further agreement; so, on July 22nd, Mr. Adamson wrote to the Electric Company, referring to the suggestions of Mr. Fuller, and stating that owing to the discredit and injury brought upon the service by the defective working of the line, the directors had decided to resume horse traction on September 1st, and in the meantime the traction was to be conducted as heretofore under the terms of the last agreement. On July 27th, the Electric Company wrote an emphatic denial that the bad service was in any way due to them, stating that the bad state of the permanent way was the real cause of the trouble, and that unless a new agreement, duly signed by the Tramway Company, was delivered by the next day, they would immediately stop the running of the cars.

The action of the Tramway Company was prompt, and indeed, the only one open to them. The Electric Company's threat arrived at the City office of the Tramway Company at 5 o'clock in the afternoon. By 12 o'clock that night, horse cars and horses were at Barking, and in the morning of the next day, July 28th, the electric cars, after running for over three years, were replaced by horse cars by order of the Tramway Company.

Mr. Adamson says "there is no doubt in my mind that the Electric Traction Company adopted the course of 'threatening' us, to force us into a fresh agreement whether we liked it or not, and I believe their letter was purposely sent to me late in the day, in order that it would reach me as it did, after my Board had risen. The instantaneous stoppage of the electric cars was certainly not expected by us, as both Mr. Fuller and Mr. Immisch, and the secretary of the company assured me more than once that under no circumstance would they adopt such a course."

This view is very different from that taken by our esteemed contemporary, whose source of information is certainly not up to date, as the following extract from the letter of the Tramway Company to the General Electric Power and Traction Company will prove. It is dated July 27th: "Having regard to the knowledge we have of the causes of the breakdowns of which we complained, and the confirmation thereof verbally made here by your Mr. Fuller and Mr. Immisch a few days ago, in the presence of the chairman of this company, I can only characterise the statements made in your letter, just received, as absolutely unfounded, and it ought to be within your knowledge that this is so.

"Knowing the views of my directors with reference to the service of your electric cars, I have no other course before me than to instantly withdraw the same from service, and will, therefore, substitute horse cars for them to-morrow morning. Under these circumstances, you must arrange, without the slightest delay, for the removal of your plant from our depôt, as the room is now required."

Further comment is needless. The question of cost of accumulator traction is not affected by the Barking trials, but the action of those responsible for the electric companies concerned has given electric tramway work in England a blow from which it will not recover for some time to come. The confidence of corporations and tramway companies has been, we fear, rudely shaken. We are informed, on good authority, that the Glasgow Corporation have definitely decided to abandon the accumulator car schemes which they had under consideration, and, no doubt, their decision has been greatly affected by the proceedings at Barking. The reports for the last year's working on the Bristol Road, Birmingham, are, also, very disheartening. The earnings are given at 13·25d., and the expenses at 15·39d., showing a net loss per car mile run, of 2·14d. There is no doubt but that the chief source of expense is the accumulator; when this is improved, and we believe there is a real advance on traction cells now in the market, there will yet be some hope for self-contained car traction.

RAILWAY TRAIN LIGHTING.

THE recent accident which occurred at Clapham Junction on the evening of the 20th will have brought before the public and the railway officials, in a forcible manner, the danger which accompanies the employment of gas as an illuminant for railway carriages. During the discussion on the paper on this subject, read before the Institution of Civil Engineers, by Mr. W. Langdon, the electrical engineer for the Midland Railway, Sir Frederick Bramwell directed attention to this very fact, pointing to that which has now actually occurred as one reason why gas should not be employed for this purpose. Naturally, and for reasons perhaps obvious, the danger attending the employment of gas for the illumination of railway carriages was not referred to in the paper itself, or much might have been made of it by the author, but he was a railway man, and, possibly, viewed from such a standpoint, his reticence was excusable. The circumstances of the Clapham accident, however, relieve us from further need of discussion upon the subject. From it we learn what may be expected from gas-lighted trains in collision. We want no argument: the facts are before us, and from them we gather that on the evening in question the 9.50 p.m. train, Waterloo to Windsor, came into collision with a train of empties returning to Clapham Junction at or about 10.5 p.m. close beside the Ludgate Junction signal box. At the rear of the empties was a van—a composite, partly van and partly carriage—and adjoining it came three carriages, all third class. With the rest of the vehicles we need not trouble ourselves. Into the tail of this train dashed the engine of the Windsor train with such force that the van was carried right over the engine and its tender, the two third-class vehicles in front of it being telescoped in the manner peculiar to such collisions. The guard of the empties was in this van, and was hurled amongst the *débris*. The gas became ignited, and an explosion is said to have instantly occurred; the brake van and the adjoining carriage were immediately in flames, and wholly, so far as all inflammable parts were concerned, reduced to ashes within a very short time. The poor guard was sadly burned, and died within a few hours. Some passengers in the Windsor train complained of injuries, and the driver and fireman were also sufferers.

On the cause of the accident—how the two trains came into collision—we do not propose to offer any remarks. That will form the subject of enquiry before the coroner and the Board of Trade, and any comments should be deferred till these enquiries have terminated. But there can be no reason why we should not consider the case in relation to the employment of gas for lighting railway carriages.

Compressed gas is now being very largely used for this purpose. It has not been in use for a very long period—perhaps hardly sufficient to test the effect of wear and tear upon the various connections. A leaky pipe at any point must mean escape. A spark from an engine falling on that spot leads to ignition of the escaping gas, and this ignition will cause fire—possibly fire, with a train at full speed. What a collision means we learn by the Clapham disaster, attended happily with comparatively slight results; but what would have been the end had those carriages, which were so quickly in a blaze, which were consumed to ashes in so short a time, been filled with human beings instead of being, as they were, empty! Doubtless that which was foreseen by Sir Frederick Bramwell, who evidently had in his mind the lamentable Abergelly accident, would have been the result, and a thrill of horror would have passed through the land. That which has happened comes to us as a warning—a warning shorn of much of its terrors—but still a warning of a very direct and unmistakeable character. We have but to imagine those burnt vehicles filled with our fellow creatures, and the sum of the disaster is before us.

On the Brighton line and on the Midland we have trains running which have for some time been lighted with the electric light. We have had ample proof of its fitness for the service. Both companies have apparently gone very fully into the question, and to them the public are indebted for their efforts to supply a light at once acceptable, and free from the danger which must always attend the use of gas. Gas is possibly cheaper in its application for vehicles, but it is questionable if it is more economical than electricity in its general working. That in its application to stock it involves less trouble than does electrically fitted stock, for the reason that it need not necessarily be kept together, Mr. Langdon, in his remarks frankly admits, but it will be clear that this difficulty, whatever it may mean, would soon pass away with a stock more liberally fitted for lighting by electricity.

Will railway companies accept the lesson conveyed to them by the Clapham Junction accident? We question it. Will it induce them to foster that to which they must inevitably resort as a means of lighting their cariages? We hope so. We cannot think but that they will see in what has happened (and that the Board of Trade, from the same reason, will also see and impress upon the companies generally the propriety of considering their position), that should the accident be followed, as undoubtedly it, in the course of time, will be by another, the result may be something far more serious. If we concede that electricity is dearer than gas; if we concede that it is more troublesome to deal with in stock partially fitted, or stock in a state of transition; even then comes the question—the all important question of safety. Unquestionably, electricity is safer than gas. What, if after these companies have fitted their stock with gas, the public outcry demands that gas shall not be used; the companies have another illuminant at their command which will afford an equally good light! The public are not, as a rule, considerate of the pockets of others; they will have what they wish, if it is to be had; and if they become terrified with mishaps of this character, some such demand may certainly be anticipated. In such a case, we should

regret that electricity had not been more fully developed, for whatever might at such a time be its position, its application would have to be made, and the cost to which the companies had been placed for gas would be sheer loss.

We cannot close this article without tendering to those companies who have, so far, sought to develop electric lighting in our railway trains, thanks for their efforts; nor can we doubt that ere long they will be repaid for the outlay which they have incurred; nor must we forget those who have worked so arduously, and with so much zeal, in the interests of those companies, in order to accomplish the wishes of their respective boards.

THE DEVELOPMENT OF THE TELEPHONE.

WE make the following extracts from letters which appeared in the *Times* on the 23rd and 24th:—

Sir,—There seems to be a misconception in certain quarters of the Press that the arrangements which have been come to between the two great telephone companies, as the result of their mutual agreement, are not likely to bear any immediate useful fruits in the public interest. It will not be long before this misconception is cleared up by the efforts which these companies are about to make to introduce, not only in the metropolis, but also in all the other large towns of England, a system of telephony more perfect even than any which exists in other European countries. The public have been led to suppose that the competition of these two companies among themselves might have produced this result in a more satisfactory manner, since competition must have led to rate cutting between these two rivals in this industry. A little consideration of the matter would, however, show that, though a lower scale of charge might have been produced, by competition, the eventual cost to the public and also to the shareholders would have been considerably greater. I need not instance the disastrous effects of rate cutting and competition generally, as they must be very well known. We have some notorious instances of the waste of capital and the cost to shareholders of rate-cutting enterprises in the matter of American Railways, and with regard to the telephone the consequences would have been even more disastrous. The establishment of two completely independent rival systems of telephony, say, in the metropolis, would mean that when the amalgamation eventually took place on the surrender of one of the rivals, the victor would become possessed of a system which would be no earthly use to amalgamate electrically with the other. The whole system would thus be crystallised into a bad system of distribution which could not be altered, and the public would therefore be, electrically speaking, inefficiently served.

As to the cost to shareholders of a competition, that speaks for itself; and as to subscribers, though they might appear to have the advantage of lower rates, they would have great inefficiency, and they would also be compelled to pay two telephone subscriptions instead of one, and have two sets of instruments in their business premises or homes. All this will now be avoided by the working arrangement that has been come to between the two telephone companies.

As to the matter of rates, this question produces some difficulty to determine at present, owing to the Government having established a system of telephone areas which will necessitate sound consideration on the part of the companies before establishing their new scale of charge. The first requirement to be met is undoubtedly efficiency. This applies not only to private service to subscribers' houses, but also with regard to the connections which are now to be made with the post offices throughout the country, and the establishment or call offices, which should be located in every town in all convenient situations. In the matter of price, it must be remembered that there will be great disadvantage in having the rate so low that the demand would become larger than it would be possible to meet conveniently from an electrical point of view. If every householder throughout the country possessed a telephone, the amount of unnecessary talking which would take place is somewhat inconceivable, and in some ways it is better that the price should be one which should have some relation to the purposes of the user. For the general convenience of the public, call offices should be largely multiplied, so that no one should be deprived from the use of the telephone from the charge being too high for a private instrument.

England is an ideal country for the development of the telephone. It is inhabited by 36 millions of people, all living in a small area, and there is no town so distantly situated from another that they cannot be put into telephonic communication. The companies have thoroughly realised the situation, both from the point of view of the public demand, and from the point of view of electrical knowledge, and it is certain that a new era is about to commence in this important industry, which will largely change business relations throughout the country. All this development has been impossible up to now. The facilities which the telephone companies possessed were absolutely insufficient even to carry out a single-wire system in an efficient manner. The powers which the Post Office now possess will be conceded by the Department to the telephone companies under certain conditions, and it is confidently believed that these powers will be sufficient to enable the companies to establish underground twin-wire systems in all large towns.

As there seems to have been some misconception in the public mind as to the attitude which the companies have assumed towards one another, and also as to the relation of the companies to the scheme which has been formed by the Post Office, I shall be very glad if, by the insertion of this letter, the public may see that the Act which was passed last session regarding the telephone industry, and the action of the companies themselves, is likely to bear immediate and important fruits.

I remain, your obedient servant,

MARLBOROUGH,
Chairman, New Telephone Company,
110, *Cannon Street, London.*

Blenheim Palace, *August 20th.*

Sir,—Ever since the prospectus of the New Telephone Company came out, on July 29th last, the public interested in the use and progress of telephony in this country have waited patiently for a statement such as the Duke of Marlborough has favoured us with in your issue of this date.

That some such statement was necessary was obvious as soon as it became apparent, by the constitution of the directorate of the board of that company, that its control must necessarily fall into the hands of the representatives of the National Telephone Company, who occupy half the seats, and whose knowledge and experience of the subject must give their influence a preponderating weight in its deliberations.

May I ask the public, through you, to consider if the letter of the Duke of Marlborough has done anything to dispel the conviction, which has naturally arisen in their minds, that the recent developments can do anything else than perpetuate a great monopoly which the possession of patents in 1880, and their protection since that date, created and maintained up till now, to the enormous retardation of the industry, and with the result of a telephone service in this country second to none in inefficiency?

The Duke of Marlborough, in his able letters to you last year, was the vehement representative of the expression of the national discontent on the subject. His letter to you, Sir, of yesterday is not the only instance of how easily the assumption of "office" may completely justify what, when "out of office," appeared worthy of every kind of animadversion.

To a large extent his Grace's letter is a repetition of the well-known and oft-repeated advantages to the community of an efficient system of telephone exchange communication.

He then proceeds to make wide promises as to the future performances of the "two great telephone companies."

The duke, in admitting to you that "we have as yet had no experience of the use of the telephone in England"—a postponement brought about by a monopoly—claims that this new monopoly, the character of which is undisguisable, will confer a great boon on the public, because he proposes to adopt certain electrical arrangements, the advantages of which were, however, nearly as well known to telephone engineers in 1880 as they are now.

He deprecates all "competition" and "rivalry," as if we in this country of railway and other competition do not know its value when we have to be served well and cheaply.

Between the lines, only the monopolist will fail to see that the demand for telephone facilities, which but for monopoly would long ago have reached vast proportions in this kingdom, is to be regulated, as heretofore, by the facilities which the companies choose to afford and by the charges they select to make.

In 1884, in a paper I read before the Society of Arts, I attempted to describe the vast development of the industry which its adoption into the daily life of the people ought to bring about; I showed how no electrical difficulties lay in the way of practically indefinite extension, how the then subscription of £20 per annum might be easily reduced to £8 for all ordinary demands, and how desirable it was that, if any great advantage (the existence of which I deny) was to be obtained by the public from monopoly, it should be in the hands of the State, when the light of public opinion can, at any rate, be brought to bear on the conditions of efficiency and cost.

The spread of the industry I had in view did not exclude "the householder," as the Duke of Marlborough suggests, and did not relegate that individual to the use of a "call" office, nor confine it to a paltry 200,000 subscribers. Nothing since then has occurred to alter the conditions then propounded.

So long as the duke bravely combatted the existing state of things and realised that they were due to the absence of healthy competition, no one more cordially went with him than I did; but there is now no misconception in my mind that the fruits which the monopoly (perpetuated by him) must bear, in spite of the Act under which he attempts to shelter it, will fall far short of what the public has had a right to expect after patiently waiting for more than 12 years for an efficient and cheap telephonic service.

Your obedient servant,

C. E. WEBBER,
Past President Institution Electrical Engineers, late Divisional Engineer Postal Telegraphs, and late Managing Director of the United (Bell and Edison) Telephone Company.

August 23rd.

Ewing's Magnetic Curve Tracer.—An error occurred in describing the specimen curves obtained with this apparatus. Under the large curve read complete H.B. *cycle.*

THE BRITISH ASSOCIATION: A REVIEW.

THE real success of a British Association meeting does not altogether depend upon the number of members enrolled, the historic features of the locality, nor upon the variety of cheap trips. It rather lies in the worth of the scientific papers and discussions, in the suggestions thrown out for future work; more, in the communications of the committees formed to carry out scientific research. By such a measure ought we to reckon the permanency of a successful gathering.

There was a time when we fondly thought of the British Association as an institution which had for its object the dissemination of science through the country, but high officials now tell us that such work is left to the technical schools, and the Science and Arts Department; that B.A. meetings are to enable scientific men to assemble together and exchange opinions; that it is, in fact, a scientific exchange, where men of attainments may impart and receive new notions. Such an avowal is the better for being a frank one, but it might open the door to a little misunderstanding. All men are directly or indirectly moved by a force which owes its birth, unconscious it may be, to self-seeking attributes. Some of the less cultured of this earth, those, for instance, who dwell in country towns, may begin to ask what advantages they would reap from a visit of the British Association to their particular neighbourhood; with the result that the great scientists of the land may gain exclusiveness at the cost of convenience.

The Edinburgh meeting, as a social function, is over, and we turn to the papers and reports which were communicated. Of the success achieved in Section A much was, no doubt, due to the presence of Profs. Von Helmholtz, Arrhenius, Wiedemann, and other distinguished foreign visitors. The lion hunting portion of the B.A. community trooped into Section A, welcomed Helmholtz in a noisy and irritating manner, scuffled for the door when he rose to go, and converted the most sober of B.A. sections into a scene of "dire confusion." The consequence was that the speakers for the greater part of the time had a difficulty in making themselves heard.

There was no doubt great personal attraction in Prof. Von Helmholtz. His well built figure, full of sturdy grace, irresistibly reminded one of the face and figure of one of the same nationality, who is now an exile from the scenes of his great and lasting political work. A speech from Helmholtz filled one with thought and admiration. Of such are the pillars on which the fabric of the great German empire firmly stands.

With this issue our readers will have had before them the chief of the papers. The sparseness of electrical papers presented to Section G was rather remarkable. We have hitherto looked upon the mechanical section as the one which could be depended upon to bring forward something of interest to electrical engineers; this year it almost belied its reputation. However, the Physical Section prevented the possible dearth of electrical subjects by bringing forth an exceedingly strong list of papers.

EDUCATION AND THE SCIENTIFIC AMATEUR.

Prof. Schuster ably presided over the Physical Section, and by a judicious application of the closure enabled the section to cover far more ground than would have been possible with a less resolute president. Not only did he preside with ability and fairness, he delivered an address which was a model of perspicuity and magnanimity. We dwelt at some length in a previous issue on this, but we cannot in a review of the work of the B.A. omit to refer to the strong and fearless attack which the Professor made upon existing educational theories, "A knowledge of scientific theories seems to me to kill all knowledge of scientific facts." Such a sentence will live when the present race of scientific tinkers has long passed away. How much of a sham present day education is will be shown in another generation. We have now reached the deplorable state of things when a man of college degrees ceases to be an educated man. He may have "gone through" a set course of reading and may become a Bachelor of Arts, and very often a prig. We by no means suggest that Prof. Schuster went as far as to suggest this. One cannot help thinking that his view of the matter was perhaps a little too generous. Of the decay of the scientific amateur the Professor had much to say. "Is it not true that the one distinctive feature which separates this from all other countries in the world, is the prominent part played by the scientific amateur; and is it not true that our modern system of education tends to destroy him." The amateur was, of course, no ordinary man, Faraday best exemplified him. The president was anxious to press home the danger of losing this one great and necessary factor in the origination of scientific ideas. It was magnanimous in one occupying a professorial chair to urge so bold a claim for the amateur, but we fear, much as we appreciate Prof. Schuster's attempt, that the amateur is by this time almost extinguished. He has become an aged man and when he has passed away there is no one to take his place. And perhaps after all the present system of education is not alone responsible. This is an age of patent making and no one really knows how much the scientific worker has been demoralised by the commercial value of inventions.

NOMENCLATURE OF UNITS.

We are afraid that we cannot speak much in praise of the discussion which took place upon this subject. Dr. Lodge, provided with a quiver full of suggestions, had come prepared for a big discussion; it must have been a little trying to find such a manifest lack of interest. The audience was thin; Prof. Helmholtz, spite of his usual attention to the doings of Section A, had gone, and with the exception of a spirited reply from Dr. Hopkinson on the proposals of Dr. Lodge, and a few words from Mr. Preece, there was practically nothing said, either for or against. It was, of course, unfortunate that the subject was not reached until late in the day, for then it was that the luncheon "loomed most big" with a prospective neglect of the "nomenclature of units." It will be remembered that, at the last B.A. meeting, many speakers gave their opinions upon the proposed alterations; there seemed to be then a decided aversion to change. The remark made by Mr. Swinburne at that meeting deserved more notice than it apparently has received. It was to the effect that Section A failed to realise what a serious matter the alteration of units was to the practical man. The alteration of units would need the ratification of a more powerful and cosmopolitan body than the physical section of the British Association. We do not say this with any intent to disparage the opinions held by leading members of this section, for no one with reason can fail to acknowledge the work accomplished by the British Association in connection with units. Still, a question so important as the alteration of units must need the approval of a vast number of electricians. It must be a source of great gratification when one hears of the unceasing and unostentatious labours of the Electrical Standards Committee; it must be a matter for national gratulation when one hears these labours extolled by no less a personage than Prof. von Helmholtz. The work accomplished by this committee is not done hurriedly for the mere purpose of presenting a report to the Association. Throughout the year experiments and comparisons have been made at the Cavendish Laboratory; how well this work has been done may be at once seen on comparing the standards obtained in Germany and England. Electricians owe much to Mr. Glazebrook, who has, perhaps, done more for obtaining accurate electrical standards than any other Englishman. Prof. Helmholtz, while applauding the accurate results obtained by the English Committee, considered resistance coils too uncertain to be used as a standard. Of the English coils sent to Germany two were found to have altered considerably. Although in his opinion it might be possible to make a coil, consisting principally of copper and nickel, which would remain unaltered for long periods, the mercury column as suggested by Dr. Werner Siemens was the safest definition.

MAGNETIC TESTS OF IRON.

The paper which, however, possessed the most practical importance was the highly interesting contribution of Prof. Ewing on "A magnetic curve tracer." We have described in our issue of the 12th, how it is possible by the aid of this instrument, which combines within itself a galvanometer with a magnetometer, the indications of both being given by a single mirror, to make rapid tests of a bar of iron, the magnetisation curve being traced out by the spot of light on a screen. To obtain permanent curves the cycle may be made slowly and followed with a marking material, or it

might be possible to obtain a permanent curve on a photographic plate. Prof. Ewing has been able to obtain as many as twenty perfect cycles in one second and he is confident that with an improved instrument he will be able to exceed this number. This instrument will be of immense service to makers of dynamos and transformers. Hitherto, magnetic tests of iron have been practically impossible in ordinary workshops, but there is now a most simple and ready means of making tests and one expects that every manufacturer would avail himself of the use of this instrument.

ELECTRICAL RESISTANCE.

We cannot give the necessary space to comment upon many of the papers read in Section A, but we will just draw attention to a communication of Dr. Dawson Turner on the influence of currents of high potential on electrical resistance. The experiments were somewhat on the lines of recent ones carried out by Branly. The author had tried many metallic powders, such as aluminium, and had found that the resistance was greatly lessened by a discharge in the neighbourhood. Of course, the most obvious explanation and the one generally held, is that there is some arrangement of the molecules which facilitates the passage of a current. It is one of the most curious things in the science of electricity that experiments are made almost daily which are simply repetitions of those done years before. Du Moncel long ago performed experiments on the electrical resistance of metallic powders. And in 1835 Munck of Rosenschold published in *Poggendorf's Annalen* the results of similar experiments. Mr. S. A. Varley made experiments in the same direction, and in 1853 applied the principle to his lightning bridges, many of which, by the way, are still in use on the Bristol and Exeter Railway. In 1870 Mr. Varley read before the British Association a most interesting paper on the subject of electrical discharge on powders, dwelling more particularly on the effect of a lightning discharge.

We must pass over the rest of the work accomplished in Section A, to touch briefly on one or two papers read before Section G.

THE UTILISATION OF WIND AND WATER.

It is within the last two or three years only that efforts have been made to devise some means of utilising the waste forces of nature; yet this activity is not so much due to the fact that we are threatened with an immediate stoppage of our coal supply, as to the fact that electricity promises to be the means of transmitting this hitherto waste power to centres of industry. It is curious that while in the economy of nature great waterfalls are, for the most part, far away from centres of humanity, it may be possible to utilise another natural force to bridge the intervening distance. There were two or three schemes submitted to the meeting, which, whether they possess real merit or not, show at any rate that the problem of using natural forces is receiving much attention. Some valuable data were given by Messrs. Purdon and Walters on the "Utilisation of the Energy of Flowing Water." The paper read before this section by Prof. Blyth on a new form of windmill, was useful, because the author had achieved some success. Although the experiment is too small to expect satisfactory figures, it is clearly shown that there is something to be done even with such an uncertain element as the wind. Wind power may be, at the present moment, considered to be the only power which is absolutely free from rent or rights of any sort. Experience gained from a few windmills would lead to many improvements in an economical working. Improved methods of storage, for storage is a *sine quâ non*, might be adopted, which would result in a cheap source of light. It is to be sincerely hoped that others will seek to emulate Prof. Blyth's work, and solve in a practical manner the question of windmills as a source of electrical energy.

We have not much to say that is good of Prof. Forbes's notion to light Edinburgh from a water supply stored in a gully which divides Arthur's Seat from the road down to Portobello. Although Prof. Forbes states that there would be no interference with the scenery, we beg leave to differ most strongly. The people of Edinburgh are but curators for the rest of mankind, and they fail woefully in their duty if they permit scientific vandals to desecrate historic scenery. No doubt the baillies' vanity was tickled to hear that Edinburgh possessed greater natural advantages for lighting their town than any other place in the kingdom. One would gather, from the report of the paper, that by adopting the system proposed, £20,000 a year would be saved in coal. Of course, this is absurd on the face of it, and we hope Prof. Forbes did not mean it seriously; be this as it may, the figures seemed to temporarily unhinge the mind of a worthy baillie who was present, and who will, no doubt, exert his influence on his fellow baillies to adopt Prof. Forbes's most doubtful scheme.

THE CURRENT THAT CURES.

BY H. NEWMAN LAWRENCE, M.I.E.E.

(Continued from page 239.)

II.

WHAT form of current cures? In considering this part of the subject, it is manifest that, in order to understand the particular form in which electric currents are most beneficial to the body, we must give some little attention to the character of the conductor to be acted upon. The human body differs from all other conductors, and therefore cannot be influenced by currents in quite the same way as other conductors are, though it is more or less subject to most, if not all, the recognised physical functions of currents. Of the heterogeneous character of this conductor, something more must be said later on; but at present it is to its resistance that attention must be given. The resistance of the body as a whole, or any part thereof (with external contacts), is considerable, and may be taken as varying between half-a-million ohms on the one side, and 214 ohms on the other; the higher figure being obtained by Wheatstone bridge method, when two small metal discs taken from an electric (*sic*) belt were used as electrodes, and weak battery currents employed, while the lower was calculated in a recent electrocution, when large wet electrodes and a powerful alternating current from a dynamo were used. The conditions under which the resistance was brought so low as the last-named figure are such that, for our present purposes, we cannot take it into account.

In electro-therapeutics, the conditions governing the resistance of the body are very different, so different, that the average value under them has been given as 7,090 ohms by the latest authority.* What the resistance of the body depends upon, I have recently endeavoured to show elsewhere.† All that it is necessary to insist upon here is that statements of the resistance of the body should always give the conditions under which the result was obtained. Dr. Hedley's figure was obtained when the skin was moistened with warm water. When salt is added, the average for therapeutic purposes may be taken as 1,100 ohms.

As the body offers so high a resistance, it is clear that any currents applied to it must possess considerable E.M.F., in order to pass through it.

The strength of current needed in medical work is, however, small. Apart from electro-surgical use, it seldom exceeds 30 milliampères, the average with continuous current being about 10 to 12 ma. It follows that, as we have to pass 12 ma. through 1,100 ohms, an E.M.F. of at least 13·2 volts is needed, without taking into consideration the R. of the battery and measuring instrument. We require, in fact, an electric energy of comparatively high voltage and small ampèrage, and this must be employed upon the body for a given time to produce certain results. Let us here consider for a few moments how far it is possible for the various electric belts to administer the current that cures. I will assume, for the moment, what is seldom the case, that such belts have their electric connections so arranged that the maximum electric energy of which they are capable is given out by them. The resistance of the body under the belt conditions is enormous. A short time ago I measured it on several people, using for the purpose a belt which had just been purchased at one of the large London establishments for the sale of such commodities. The average resistance

* "Hydro-Electric Methods in Medicine," by Dr. W. S. Hedley.

† Paper by Author before British Association at Edinburgh, 1892 on "Human Body as a Conductor."

was over 800,000 ohms. As this particular belt had rather small discs, I will assume that the figure may be less with others whose contact discs are larger or differently arranged. Let us be charitable, and call it one-half, *i.e.*, 400,000 ohms. To pass the average therapeutic current given above, the belt should possess an E.M.F. of 5,000 volts. The people who sell these things tell us, however, that a very small current is sufficient to cure if it be applied constantly, and that their belts excited to action by the perspiration do this, but to pass even a tenth part of one milliampère through such resistance requires 40 volts, and this is at least 10 times more than the best of such belts is capable of.

After the recent exposure of so-called electric belts in the Bloomsbury County Court, there is no need for me to pursue the subject further, especially as about the same time an able article on electrical appliances, by Dr. Hedley, appeared in the *Provincial Medical Journal*. It seems, therefore, that a calm consideration of facts can bring us to only one conclusion, and that is that the "current that cures" is *not to* be obtained from *any body belts or appliances* which rely upon the *excretions of the skin for their action*. There are, however, appliances which contain in themselves a complete battery, and which do generate small currents at sufficient E.M.F. to overcome the skin resistance. These are at least honest, for they are what they profess to be, *i.e.*, "electric." Their therapeutic value is another matter, and when the smallness of the currents generated by them, their necessarily irregular action, and the impossibility of adapting them to any proper method of dosage, are taken into account, it is hard to see that they can occupy any important part in supplying the form of current that cures.

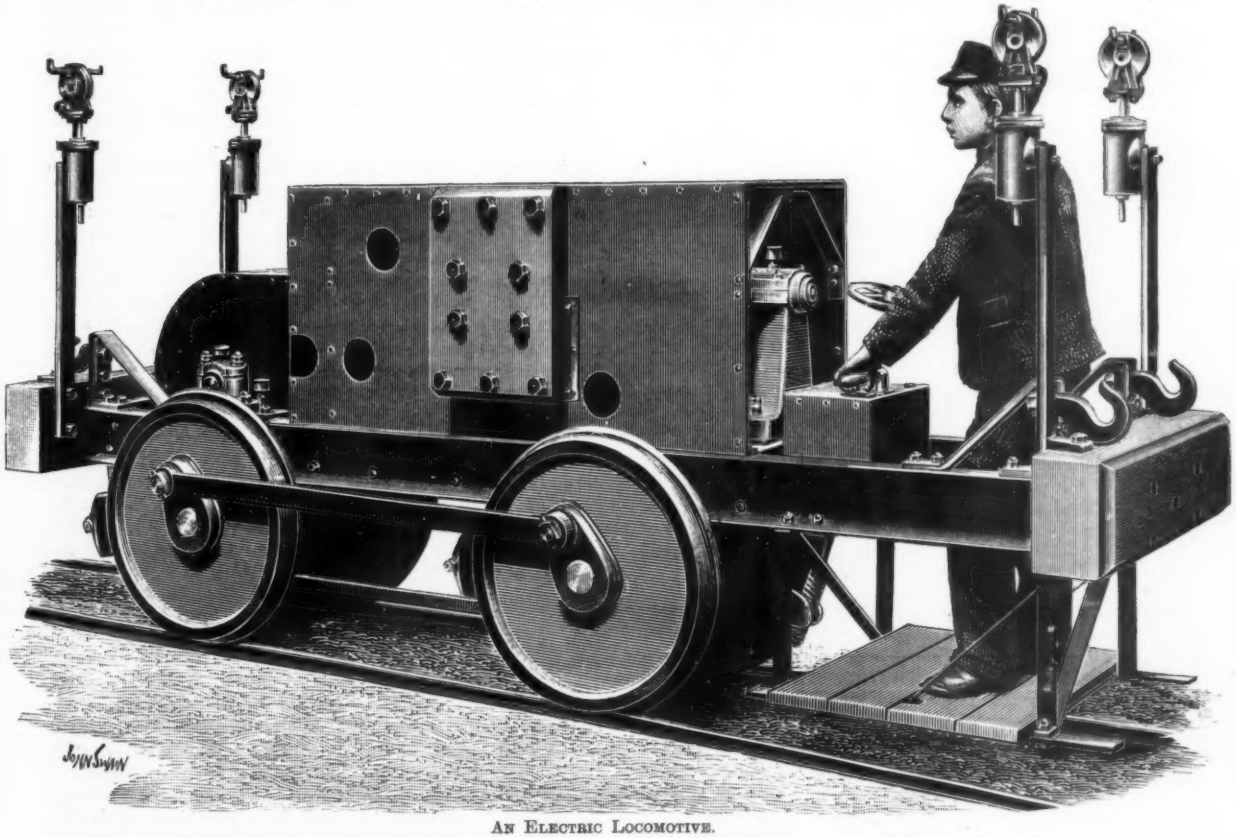
I cannot leave this reference to body appliances without noticing the claims of some individuals to pass currents (sometimes even drugs, also) into the body by means of small magnets attached to pads or garment. I will quote the above-mentioned article from the *Provincial Medical Journal*:—

"There is another class of appliance in which it seems to be expected that the mere presence of small magnets will set up electrical currents in the part of the body to which it is applied. Now, so far as I know, it is one of the canons of science that in order to produce electrical currents by magnetism, either the conductor must be moved relatively to the magnet, or the magnet moved relatively to the conductor, so that the conductor may cut the lines of force existing in the magnetic field: and that without such cutting of lines of force no current can be set up in the conductor. Now, if I find that in any appliance when the conductor (*i.e.*, the body) moves, the magnets (and their very feeble magnetic field) being attached to the body, move with it, it is obvious to me that no relative movement of the one to the other takes place. Therefore, I conclude that the fundamental principle on which the generation of electrical currents by magnetism rests is ruthlessly violated; and I know what to expect—or, rather, what not to expect—from such an arrangement."

How a current which does not exist (as shown in the above quotation) can carry drugs in solution where it goes not itself requires some little explanation. Probably, however, the ingenious gentleman who claims such power for his appliance is equal to the occasion.

While it is true that infinitesimal currents do not cure, it is also true that very great ones do not either. The very qualities that enable small currents to act upon the body beneficially become a harmful and even dangerous element with large currents. As a drug may be useless in infinitesimal quantities, curative in moderate quantities and dangerous when taken largely, so it is with electricity. This points to the need for accurate dosage therein, and the want of attention to this matter is most lamentable in nearly all the medical works on the subject. Measurement is a very essential item in any form of the current that cures. Medical men would laugh to scorn the idea that the drugs they prescribe need not be measured or weighed, nor the doses accurately described. Why, then, should they content themselves with haphazard and happy-go-lucky methods when administering or prescribing electricity, about which, at least, equal care is necessary?

(To be continued.)



An Electric Locomotive.

AN ELECTRIC LOCOMOTIVE.

The accompanying illustration represents an electrical locomotive recently made by the General Electric Power and Traction Company, Limited, at their Kentish Town works, and is part of a large installation supplied to the Greenside

Mining Company, Cumberland. The locomotive is for mining work underground, the road on which it runs being in some places as narrow as 32 inches, the gauge of rails being 22 inches.

It was found impossible in the small space available to place the motor across the frame with its shaft parallel to the axles, so it was arranged parallel to the rails. Three reductions of gearing are employed, one necessarily being through bevel gearing. The whole framework of the machine is hinged from the driving axle, which is made exceptionally strong for the purpose, the weight on the other wheels being taken through strong spiral springs on the top of gun metal axle brasses.

The design of the "Immisch" motor, as shown, was chosen owing to the protection afforded to the field windings by this type of machine.

The motor is series wound for a difference of potential of 200 volts, and develops 15 brake H.P. at 1,000 revolutions per minute. The length of the road is 1,200 yards, and the current is collected from two bare copper wires carried on insulators overhead. The E.M.F. is reduced from 500 volts to 200 volts by means of a motor transformer placed at one end of the line. The whole installation is rendered doubly interesting from the fact that a copious natural supply of water on the side of a hill is utilised as a prime source of power to drive a large "Vortex" turbine, the water being conveyed down the hill through 15-inch pipes. A building has been erected on the hillside of this wild looking country, in which the turbine drives an "Immisch" 4-pole dynamo which develops 100 electrical H.P. at about 600 revolutions per minute. The dynamo is compound wound with a working difference of potential of 600 volts, and supplies current also for motors driving pumping and winding plants besides lighting the colliery both above and below ground.

NOTES.

Huddersfield and Electric Lighting.—At the last meeting of the Huddersfield Town Council a long discussion took place with respect to a proposed expenditure of £900 for fitting up the sewage works with the electric light. It was explained that this would be the only cost, that there would be motive power at the works which would otherwise be wasted, and that the advantages in an open place like the sewage works of the electric light over gas would be very great. To light up the place with gas would cost £150 a year, and the interest on the outlay for the electric light would only be £50. By a large majority the Council agreed to the expenditure.

Government Acquisition of the Cable Companies.—We hear that Mr. Henniker Heaton, M.P., has given notice that he will propose the following motion in the next Session of the House of Commons: That freedom of communication by cable is one of the most vital interests of the Empire, and, as such, ought not to be dependent on the policy of private companies; that it is in the highest degree expedient to encourage, cheapen, and facilitate communication by means of the electric cable between the several portions of the Empire; that the rates charged by the cable companies for the transmission of messages are, generally speaking, excessive, and in some cases, prohibitive; that, it being advisable at all costs to put an immediate end to cable monopolies; the British Government (or the Home and Colonial Governments jointly) ought forthwith, in the interests of the Empire, to acquire at a fair price the rights, plant (and other property, if any) of the existing cable companies; that the price paid should not exceed the market value of the cable companies' shares on the date of the appearance of this proposed resolution in the paper; and that the State (or the Imperial Cable Administration), when possessed of the cables, should aim at no profit on the transmission of cablegrams, but should charge rates low enough to allow of the despatch of the largest possible number of messages, after providing for the cost of maintaining the cables and the service generally in an efficient condition, the cost of any extension of the imperial cable system being met by a further investment of State funds.

St. Thomas Charterhouse Schools.—Notwithstanding the oft reiterated complaint of the examiners of the Science and Art Department of South Kensington, that a very large number of examinees were totally unfit to cope with the papers set, still the successes of the pupils of the St. Thomas Charterhouse school have always been brilliant, and this year's results are superior to those of any previous year. Every pupil of the upper class (some 53 in number) sat for practical solid geometry, mathematics, magnetism and electricity, acoustics, light and heat, most also for physiography, whilst a few took in addition, chemistry; although the pupils average 13·5 years of age, 180 passes were obtained, and of these nearly 70 were distinguished as "First Class." Ethelbert Dinmore succeeded in scoring five first classes. Many of the old pupils of this school are occupying important public positions in consequence of their knowledge of scientific subjects.

New Telegraph Line.—A through telegraph wire from Calcutta to Madras is about to be erected. The length of the new line will be 1,900 miles.

Statistics of Telephone Companies in the United States.—From a census report on telephone companies in the United States during the census year (1890), it is possible, says the *Times*, to gather some idea of the enormous development which this new industry has undergone during the past decade. It is important to remember that at the beginning of the previous census year, 1879-80, the business of telephone companies in the United States amounted to little or nothing. During that year the business passed through the stages of an unprecedented development. This is strongly brought out by the fact that in 1880 there were no less than 148 telephone companies or firms reported as engaged in the business. In 1890 this number was reduced to 53; but this is the only respect in which a reduction is reported. In every other respect the statistics show an enormous increase. The total amount invested in the business in 1880 was $14,605,787, in 1890 it was $72,341,736; the gross earnings in 1880 were $3,098,081; in 1890, $16,404,583; the gross expenses in 1880 were $2,373,703; in 1890, $11,143,871; the net earnings which in 1880 were $724,378; in 1890 were $5,260,712; the number of exchanges had increased from 437 in 1880 to 1,241 in 1890; the number of telephones and transmitters, which in 1880 was 108,638, in 1890 was 467,356; in 1880 there were 34,305 miles of wire, in 1890 there were 240,412 miles; the number of *employés* in 1880 was 3,338, in 1890 it was 8,645; the number of subscribers, which in 1880 was 48,414, had increased in 1890 to 227,357. No record was kept of the number of conversations during the former year, but in 1890 they reached the enormous total of 453,200,000. The report points out, moreover, that interesting as are these statistics, it is impossible by such methods to convey a proper representation of the actual changes that have occurred in the business of operating telephone companies during the decade from 1880 to 1890. Improvements in instruments and exchange switchboards, changing from grounded to metallic circuits, placing wires underground, extension of lines to extra territorial districts, and, finally, the introduction of long-distance service, combine to make the service rendered in 1890 more valuable and satisfactory to subscribers than the service rendered in 1880.

Electric Light Machinery and the Vaudeville Theatre.—The Vaudeville Theatre has been the subject of a somewhat lengthy arbitration between Mr. Thomas Thorne, the lessee and manager, and Messrs. A. and S. Gatti. The arbitration arose in consequence of complaints made of alleged vibration to the theatre owing to the erection by Messrs. Gatti, of engines for electric lighting purposes. Owing to these complaints, Messrs. Gatti agreed to purchase the lease of the theatre held by Mr. Thorne for an unexpired term of 21 years. The value of this lease has been the subject in dispute. On behalf of Mr. Thorne a total claim of £29,542 was put forward, while the purchasers value the lease at between £8,000 and £10,000. The arbitrator (Mr. F. T. Galsworthy), who sat and took evidence for six days in June and July, has now awarded £15,859 as the sum to be paid for the lease of this theatre.

Electric Lighting on Southampton Pier.—At a meeting of the Southampton Pier and Harbour Board last week, it was reported that the official trial of the electric lighting of the Royal Pier took place on July 25th, and proved entirely satisfactory. The electrical engineer reported visiting the works of Messrs. Stothert & Pitt, and it was resolved that they should be permitted to complete one of the electrical cranes first. A member, in moving the adoption of the report, which was agreed to, said that the electric lighting arrangements were now perfect.

The Blackening of Incandescent Lamp Bulbs.—The troubles of incandescent lamp makers have been again and again dilated upon in these columns and sympathetically, too, but we must still insist upon calling their attention to such of their difficulties as react upon the consumer and cause him inconvenience. We must not only please but satisfy the public if we wish to go ahead or even maintain our position. From the consumer's point of view one of the chief charges that can be brought against the incandescent electric light consists in the fact that the efficiency falls off with use. At the electrical laboratory of the Ohio State University, a prolonged inquiry has recently been conducted into the "life" and efficiency of the incandescent lamps of ten different American makers. The results showed that the mean candle-power of the lamps rated at 16, did not exceed 14·5 ; that the candle-power falls off with use approximately at the rate of 10 per cent. for each 200 hours ; that the life of 96 out of 127 lamps exceeded 1,100 hours, and that the average initial efficiency was 4·2 ; after 600 hours, 5·6 ; and after 1,200 hours, 7 watts per candle-power. These results speak volumes, and we advise lamp makers "to read, mark, learn." We notice that one of the most interesting results indicated by this investigation was that the blackening of the lamp-bulbs is not entirely due to the deposition of carbon particles from the filaments, but largely due to vapour of mercury left in the lamp-chamber by the Sprengel pump. The evil was far less apparent in lamps exhausted by pumps which involved the use of no mercury. Perhaps the chemists can tell us why it is that this blackening takes place. Is it possible that minute quantities of sulphur may exist in the filament and may combine with the traces of mercury vapour, after a time forming black solid mercury sulphide ?

Electrical Engineer for Maidstone.—At a meeting of the electric lighting committee of the Maidstone Local Board on Friday, it was recommended that Mr. W. C. Hawtayne should be engaged to prepare the necessary plans, estimates, and specifications, and carry out the entire scheme for the lighting of the borough with electricity, and that he be also permanently engaged to manage and start the lighting, and required to act as residential engineer in charge of the works for a period of at least 12 months after their completion. After a deal of discussion it was decided to hold a special meeting of the whole board to discuss the matter.

The Electric Light in Exeter and Taunton.—Mr. Massingham, Managing Director of the Exeter Electric Lighting Company, has written a letter to a West of England daily paper, in the course of which he says :—"Last year the Exeter Company made a larger loss than the Taunton Company, and the directors were naturally afraid of continuing the works, whereupon Mr. Massingham offered to secure them against all loss, and, in addition, to guarantee them a minimum income of £300 the first and £500 the second year if they handed over to him the sole and exclusive control of the works. The loss last year was £822 10s. 2d., the profit this year is £273 12s. 6d. as a result of the acceptance of Mr. Massingham's offer."

Fireman's Exhibition.—The second Fireman's Exhibition is now being held at the Aquarium, and will remain open till the end of the month. Messrs. Stockman and Doyle exhibit the "Absolute" fire alarm, which is partly pneumatic and partly electric, and consists of a small drum of air with which a tube is connected, having at its end a valve arranged to force a button so as to complete an electric circuit and ring an alarm. In the case of an outbreak of fire the heat expands the air in the drum, causing pressure in the tube and against the valve.

Transformers. — Prof. Rowland has recently gone briefly into the effect of introducing terms in the equations of induced currents to approximately represent effects due to varying permeability. The result he arrives at is of some interest, as it confirms an experimental result which Prof. Ayrton has mentioned as being obtained by some of his students. Prof. Ayrton said (in a paper before the Institute of Electrical Engineers) that the odd harmonics had been detected in a transformer current, and these are the very harmonics Prof. Rowland predicts. While on the subject of transformers, it is interesting to note that the experimental determination of the importance of inductive drop by Prof. Ayrton and Mr. Smith was published at the B.A. meeting almost simultaneously with its theoretical prediction by Mr. Swinburne in *Industries*. It is a point of some little importance, an l does not seem to have received much attention up to the present.

Electric Lighting at Hove.—After many delays, probably owing to financial difficulties, the Hove Electric Light Company has at last been registered. In 1890 the Hove Commissioners decided to transfer their electric lighting order to a private company, but as one of the terms under which the order was obtained stipulated that the lighting, both public and private, should be in operation in the compulsory area within two years, it remains to be seen whether the Board of Trade will consider the excuses for the delay sufficient to justify them withholding an order from the Brighton and Hove Electric Light Company, who have given notice of their intention to apply for a Provisional Order in the coming session of Parliament. The Brighton company have a large and increasing business, and have announced their intention of reducing the present charge for electricity by 20 per cent., making the price 8d. per Board of Trade unit. The two companies are bound to conflict, but the consumer must necessarily benefit by the competition. The new company will commence by supplying electricity at 8d. per Board of Trade unit.

"Where was Moses when the Light went out ?"—In the last number of *Truth* appears, on the unimpeachable authority of Moses, the following answer to a correspondent :—

"C. H. J., Upper Clapton.—Progress has been impeded by the difficulties so often encountered with the working of new processes, but the business in itself is good, and dividends should eventually be earned. I will make inquiries about the weekly output. The remarks in the electrical paper are grossly biassed."

It will scarcely require a seer to divine what process is referred to, though we should think the process is rather old by this time, as well as the tale of the weekly output. Further comment is superfluous. Still we cannot help wondering at the simplicity, or something else, of the person named "Moses."

Heckmondwike Electric Lighting.—A lengthy meeting of the Heckmondwike Board of Health was held on Monday last week, when the matter of electric lighting was very fully discussed. The scheme proposed by the committee was the low tension system, and the estimated cost of the working plant was £4,450, and by adopting that scheme it was stated that, at a charge of 7d. per Board of Trade unit, they could make a profit of £400 per annum. It was proposed that a provisional order be applied for, and that sanction to borrow the necessary amount be obtained. It was, however, ultimately agreed that before any further steps be taken, the ratepayers should be consulted regarding the matter.

Dublin Electric Lighting.—Last Friday evening, Mr. Robert Hammond, of the firm of Hammond & Co., who have completed the Dublin Electric Lighting Station, gave a private press inspection of the machinery and electrical apparatus. One of the machines was tested on Thursday night with most satisfactory results, and Friday's tests, it is said, were equally encouraging. The Corporation will, it is expected, take over the works in the course of a fortnight.

Electric Lighting of Hospital Ships.—At a meeting of the Metropolitan Asylums Board, on Saturday last, it was resolved that a supply of electric lighting cable, at a cost of £120, be purchased for lighting the hospital ships.

Waterford and Electric Lighting.—We understand that the Corporation of Waterford has just decided to abandon the electric light. The contract for lighting the city having expired the contractor increased the price. The Corporation refused to pay, and have fallen back on gas, and the electric lamps will be extinguished on September 1st. In Cork, where the Great Southern and Western Railway Company have built a new station they have decided to rely upon gas as an illuminant, although their old station is lighted by electricity.

The Institution of Civil Engineers.—The Council of this Institution invites original communications on the following subjects:—The Cost of Working Electrical Tramways, taking account of interest on capital, and of a sinking fund for depreciation. The Disposal of Town Refuse by Burning, and the application of the heat thereby generated. The Carburetting of Gases for Illuminating Purposes. The most suitable form of Electric Light Mains, having regard to durability, economy of conducting material, and facility for making and laying house connections. The Risks of Electric Lighting to life and property, with the means to be taken to prevent or lessen them. The best Arrangement of Engine for any given Electric Light Station. Electrical Motors for (*a*) Inland Navigation; (*b*) Ocean Vessels. The Manufacture of Aluminium and its Alloys. The Electro-deposition of Copper. On the application of Water Power and its Transmission to a distance by Electricity. The Design of Electric Locomotives. The Practical Working of Multiphase Alternating Current Motors. Premiums have been awarded by the Council as follows:—A Telford Medal and a Telford Premium to Alexander Pelham Trotter, B.A., Assoc.M.Inst.C.E., for his Paper on "The Distribution and Measurement of Illumination." A Telford Premium to Prof. William Chandler Roberts-Austen, C.B., F.R.S., for his Paper "On the Measurement of High Temperatures." A Telford Premium to Charles Preller Sheibner, Ph.D., Assoc.M.Inst.C.E., for his Paper on "The Florence and Fiesole Electric Railway." A Miller Prize to Charles Henry Wordingham, A.K.C., Stud.Inst.C.E., for his Paper on "Meters for Recording the Consumption of Electrical Energy."

Application of Destructors to the Lighting of Edinburgh.—In our report of Prof. George Forbes's paper before the B.A., a mistake occurred. We stated that a saving of 2d. per lb. of coal, &c., instead of a saving of 2 lbs. of coal per horse-power.

The Thermo-dynamic Value of Towns' Refuse.—At the present moment, when the employment of the heat produced by the destruction of towns' refuse, for generating steam for electric lighting purposes, is before the scientific world, the following abstract from a paper read before the Liverpool Engineering Society, by the city engineer of Liverpool, Mr. Percy Boulnois, M.Inst.C.E., may be usefully reproduced. Mr. Boulnois stated that he had received some valuable information from Mr. B. H. Thwaite, on the subject of the thermal value of house refuse, from which the following was abstracted:—"The thermal value of the organic matter has been rigidly tested by the calorimeter, and the net value available, for external thermo-dynamic work may be expressed by the formula

$$Y = \left(\frac{X \times 2 \times 80}{20}\right) \times 1{\cdot}25,$$

where Y represents the net available thermal value for motive power purposes, and X represents the corresponding value of coal. For instance, 2 lbs. of coal is required for providing the motive power equivalent to one brake horse-power per hour, the amount of refuse that would be required to effect the same dynamic effect would be:

$$\frac{2 \times 2 \times 80}{20} \times 1{\cdot}25 = 20 \text{ lbs.},$$

or 10 times the weight of coal required to do the same work. The factor 1·25 is, arbitrarily, fixed to represent the internal work of evaporation and self-destruction. The proportion of water in organic vegetable matter may vary from 10 per cent. to 90 per cent." These facts are particularly interesting, in the face of the recent statements of Prof. George Forbes.

Antifriction Materials for Bearings used without Lubricants.—The Carboid Oilless Bearing Company say that a slight error occurred in our report of Mr. Killingworth Hedges paper published in the ELECTRICAL REVIEW on August 12th. The specific gravity of the carboid self-lubricating material is given as 1·66, which is correct, but ordinary carbon is 1·48, not 1·68. Our readers may be interested to learn that this material will be exclusively employed for the bearings of the shafting in the Laundry Exhibition which was to open on the 25th inst. at the Central Hall, Holborn.

Crystal Palace School of Practical Engineering.—The 32nd session of this school concluded on Saturday, the 6th inst., when the certificates were presented to the successful students by Mr. Latimer Clark, past-president of the Institution of Electrical Engineers. The students obtaining the highest marks in the electrical section were H. C. Rose and J. C. Lyell.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Edison and Swan United Electric Light Company, Limited.—The annual return of this company, made up to the 2nd inst., was filed on the 8th inst. The nominal capital is £1,000,000 divided into 150,000 "A" and 50,000 "B" shares of £5 each. 106,400 "A" and 23,564 "B" shares have been taken up, and a call of 10s. per share on 89,261 "A" shares has been made, resulting in the payment of £44,630 10s. 89,261 "A" shares have been issued with £2 10s. paid, and 17,139 "A" and 23,564 "B" shares have been issued as fully paid, making a total sum of £471,298 issued as fully paid. Registered office, 100, Victoria Street, London, S.W.

Eastern and South African Telegraph Company, Limited.—The annual return of this company, made up to the 5th inst., was filed on the 17th inst. The nominal capital is £600,000 in £10 shares, all of which is taken up, the full amounts called, and all calls paid. The Eastern Telegraph Company, Limited, holds 58,993 of the 60,000 shares, the remainder being principally held by the directors. Registered office, Winchester House, Old Broad Street, London, E.C.

United River Plate Telephone Company, Limited.—The annual return of this company, made up to the 9th inst., was filed on the 15th inst. The nominal capital is £500,000 in £5 shares. 58,000 of these have been taken up, of which 16,000 have been issued as fully paid. The full amount has been called and paid on the remaining 42,000 shares. Registered office, 53, New Broad Street, E.C.

BUSINESS NOTICES, &c.

The Electric Light in the West End.—Since our last report of the progress of electric lighting in this district, we note that the Electrical Supplies and Fittings Company, of Charing Cross Road, W.C., are fitting up some new premises, known as Granville House, in Arundel Street, Strand.—Messrs. Becker & Co., of Gertrude Street, Chelsea, are fitting up the premises of the Cheque Bank, Limited, Waterloo Place, W.—Messrs. Hulett & Co., of High Holborn, are doing electrical work at 95, Holborn, while Mr. T. W. Fewster, of Lorne Gardens, N.W., has recently fitted up the premises of Mr. L. Marcus, jeweller, 72, Oxford Street—An installation has also recently been completed in the premises of the International Stores, 86, Oxford Street.

Evans, Stewart, Palmer & Company.—This firm has the contract for a large electric light installation, which they have commenced work on, at Nops Electrotype Agency, 19, Ludgate Hill, E.C.

Ernest Scott & Mountain.—Messrs. Ernest Scott and Mountain, Limited, engineers, Close Works, Newcastle-on-Tyne, are extremely busy in both their electrical and engineering departments. In the former department, they have just secured the contract for the lighting of the Co-operative Wholesale Society's premises in Waterloo Street and Thornton Street, Newcastle-upon-Tyne. This installation is said to be, perhaps, the largest driven by gas engines in the kingdom, the plant consisting of three 25-H.P. nominal gas engines, to give 55 effective H.P. each, three Tyne compound-wound dynamos to run 400 16-C.P. lamps each, and about 800 16-C.P. lamps fixed throughout the premises. In addition to this, the firm have the contract for lighting the Ashington Colliery throughout, and are also lighting Messrs. Chadwick Bros. mill in Russia. They have more recently secured the contract for an electric pumping plant for the Newton Colliery Company. This plant is to be capable of delivering a maximum of about 200 gallons of water per minute. In the engineering department, Messrs. Ernest Scott & Mountain are extremely busy with their specialities in connection with auxiliary machines for war-ships. They have in hand for the Admiralty six duplex pumps of the Worthington type, with cylinders 9 inches by 6 inches by 9 inches. They have also in hand an order from the India Office for their Admiralty type of pump, and are building a considerable number of this type of pump, also, for various contractors doing Admiralty work. They are also busily engaged with fans, having recently secured orders for a considerable number from various firms.

The Electric Light in South London.—The adoption of electric lighting in South London, though not so rapid as in the City, is making slow but steady progress. The Star Hotel, Walworth Road, S.E., has recently been fitted with an installation by Mr. J. Torr Todman, of Bermondsey Street, S.E.—Installations have also been recently completed in the following premises:—The Railway Tavern, Duke Street, S.E.; the Auction Rooms of Messrs. H. & A. Layman, London Bridge, S.E.; F. Quelch, hairdresser, High Street, Borough, S.E.; Messrs. Straub & Hebbing, watchmakers and jewellers, 38, Blackman Street, Borough; and Messrs. Layman, 102, High Street, Borough.

Birmingham Telegraph Factory.—The new catalogue issued by the Birmingham Telegraph Factory is a great advance on preceding editions in many respects. It is beautifully printed on highly finished paper, in the American style, by Goldie, of Glasgow, the British expert in this class of work. The illustrations are produced from photographs of the actual articles manufactured, and the prices have been revised since the issue of the former edition. The catalogue includes telegraph instruments, domestic appliances, resistance coils, electric bells, galvanometers, keys, switches, telephones, indicators, batteries, wire, poles, ironwork, and all other requisites for telegraphic line construction.

Tenders Wanted—Belem do Gram-Para (Brazil).—Tenders for lighting the city of Belem do Gram-Para, United States of Brazil, by gas or electricity, will be received up to November 30th, at the office of the Secretary to the Municipal Council of Belem do Gram-Para. Particulars can be had on application to the Brazilian Legation, 55, Curzon Street, Mayfair, London (where a plan of the city may be seen), or to the Brazilian Consul-General, 6, Great Winchester Street, London, E.C.

Telegraphs in Egypt.—The India Rubber, Gutta Percha and Telegraph Works, of Silvertown, has received an order from the Egyptian Department of Railways for two miles of cables, and 500 kilogrammes of soft galvanised iron wire.

Tenders Wanted—France.—The Minister of Commerce and Industry, Rue de Grenelle, 103, Paris, is inviting tenders until September 2nd for the supply of nine sets of telegraphic apparatus (Baudot system) for the Posts and Telegraphs Department.

Tenders Wanted—Austria.—The municipal authorities of Gratz are inviting tenders until the 31st inst. for the erection and working of a central station, for the purpose of providing current both for lighting and power purposes.

T. L. Hemming & Company.—Mr. Leoline A. Edwards, of 19, Laurence Pountney Lane, Cannon Street, has been appointed sole London agent for Messrs. T. L. Hemming & Co., Limited, who appear to be rapidly coming to the front as manufacturing electrical engineers.

CITY NOTES.

The City of London Electric Lighting Company, Limited.

THE following is a copy of the directors' first annual report and balance-sheet. We are informed that further details will be given by the chairman at the meeting to be held on September 1st, and that a much fuller balance-sheet—made up to December 31st next—in the form prescribed by the Board of Trade, is to be circulated early in 1893:—

The directors beg to submit their first annual report and statement of accounts for the period ended June 30th, 1892. The board has constantly pressed forward the necessary work, and the progress made is satisfactory. All the provisional orders and contracts are now in the possession of the company, and the former have received the Royal assent. The directors have secured, on favourable terms, the freehold of the Bankside central station, and have entered into an "agreement for a lease" of 90 years for the other central station at Wool Quay. Suitable buildings have been erected for all plant now running. Additional buildings for the machinery on order are in progress, the work for which is being carried on by night and day. Sites for several transformer stations have also been acquired, and the necessary work of construction and equipment is far advanced. Contracts for the full equipment of plant for the generating stations have been entered into, under such conditions and specifications, as will ensure all material and work being of the highest class and efficiency. There is already installed machinery of a capacity of 700 public arc lamps, and 23,000 8-C.P. glow lamps, including reserve. Additional machinery of a capacity of 56,000 8-C.P. glow lamps is being constructed; part of this is expected to be running by the end of October, and the remainder in the early part of 1893. The arrangements for duly executing this work within the limited time allowed by the contracts, formed the subject of serious consideration by the board. With the object of avoiding the inconvenience to the public, inseparable from frequent opening of the same streets, it was decided to lay, at one operation, "ways" sufficient for immediate requirements, together with a number of spare tubes to meet all probable developments of the company's business. By recent legislation, electrical supply companies are authorised, subject to certain consents, to lease for telephonic purposes any spare tubes they may have. 184 arc street lamps were in use on June 30th. The greater number of lamps contracted for will be in operation by about the middle of September. The final date for completion specified in the contracts is November 5th, 1892. The demand for private lighting continues to be exceedingly good. On June 30th signed applications had been received for 32,028 lamps, mostly from the limited area in which current was then available. Of this number 11,860 were connected up. The directors have endeavoured to make their capital outlay earn revenue at the earliest possible moment, having regard to the proper execution of the work and the provision of adequate reserve power. The result is, that a considerable income is already accruing. Public and private lamps installed at June 30th were estimated to be earning at the rate of £14,600 per annum, a figure which is daily increasing. From calculations based on the lamps already connected to the company's mains, it appears that the consumption of current per lamp installed in City offices, shops, &c., will be much greater than was anticipated. There is every indication that the position of the company is exceptionally favourable. Messrs. W. H. Pannell & Co., the auditors, retire, and, being eligible, offer themselves for re-election.

CAPITAL ACCOUNT—Receipts and Expenditure, including Liabilities to June 30th, 1892.

Cr.	£	s.	d.
To Share capital authorised— £400,000 in 40,000 ordinary shares of £10 each, and £400,000 in 40,000 preference shares of £10 each	800,000	0	0
„ Share capital issued— 36,410 ordinary shares of £10 each, £364,100; less, calls in arrear, £1,514	362,586	0	0

NOTE.—Under existing contracts relating to the equipment of the stations and other works there are further contingent liabilities, which become due only after delivery, and final testing of the plant.

Dr.	£	s.	d.
By amount paid to the Pioneer Company under the agreement of July 13th, 1891, for works executed and other matters, £94,000. Less money unexpended and returned, £24,699 14s. 11d. ...	69,300	5	1
„ Land and buildings, including law charges incidental to acquisition	37,298	12	5
„ Plant:—Boilers, pumping, feed-heating appliances, engines, arc dynamos, alternators, exciters, transformers, accessories, &c.	80,603	11	8
„ Mains (including cost of laying and re-paving), lamp-posts, lanterns and lamps, &c.	141,672	2	6
„ Meters and electrical instruments	1,215	18	8
„ Tools and implements	1,414	8	3
„ Office furniture	291	16	8
„ Remuneration of chief engineer and professional charges	6,000	0	0
„ Cost of obtaining the four provisional orders under agreements with the contractors... ...	6,500	0	0
„ Expenses of trials, running and maintenance of lighting at central stations	4,335	16	5
„ Directors' remuneration	1,000	0	0
„ Salaries, rent, rates, insurance, legal and general expenses	5,320	11	6
	354,953	3	2
Less—Sale of current, £2,098 2s.; meter rentals, £42 14s. 5d.; transfer fees, £44 15s.; dividends on securities, £15 2s. 8d.	2,200	14	1
„ Net amount of expenditure carried to balance sheet	352,752	9	1
„ Balance	9,833	10	11
	£362,586	0	0

BALANCE SHEET AS AT JUNE 30TH, 1892.

CR.	£	s.	d.
To capital account, receipts as per statement ...	362,586	0	0
„ Sundry tradesmen and others due on construction of plant, machinery, fuel, stores, &c., to June 30th, 1892	23,398	16	10
„ Sundry creditors on open accounts	4,544	12	10
	£390,529	9	8

CR.	£	s.	d.
By Capital account, expenditure as per statement ...	352,752	9	1
„ Sundry debtors for rent, &c.	834	3	9
„ Sundry debtors for current supplied	2,052	3	4
„ General stores on hand	4,332	5	8
„ Sundry deposits under provisional orders, &c. ...	7,001	0	9
„ Expenses of subsequent issues of ordinary capital—£2,005 2s. 4d.; less premium received on 6,258 shares, £1,564 10s.	440	12	4
„ Cash at bankers	23,116	14	9
	£390,529	9	8

The Telephone Company of Ireland, Limited.

THE directors' report for the year ended December 31st, 1891, states that the business of the company continues to show a steady development. The number of wires, exchange and private, under rental upon December 31st, 1890, was 1,473. On December 31st, 1891, the number was 1,538, being an increase of 65 for the year, notwithstanding the great interruption caused by the severe snowstorm of November, 1890, which paralysed the company's business in Dublin during the early months of the year 1891. The increase in the number of subscribers still continues, and coupled with the reduced amount payable for instrument royalties, cannot fail to have a favourable effect upon the revenue for the current year, and a still more favourable effect in the ensuing year, when the instrument royalties will altogether cease. It has been considered prudent to write off from the revenue of the year the whole of the expenses (£1,262 3s. 2d.) connected with the issue of the debentures, and also the whole of the allowances (£672 4s. 8d.) made to the company's subscribers during the period when the system was under repair after the damage caused by the snowstorm in November, 1890, and also to write off on account of bad and doubtful debts a larger amount than usual, namely, £368 11s. 10d. as compared with £181 8s. 7d. for the previous year. Were it not for these very exceptional deductions the balance of gross revenue transferred to net revenue account would have been £5,821 10s. 6d. instead of £3,699 19s. 5d., as against £4,646 14s. 11d. for the year ended December 31st, 1890. Out of the proceeds (£10,995) of the issue of £12,100 debentures made last year, a sum of £5,000 was paid to the parent company on account of royalties and arrears. Of the balance (£5,995) £4,000 is invested in Dublin Corporation 3½ per cent. stock. All expenditure upon capital account during the year, including the cost of erecting the trunk line to Belfast, has thus been practically borne by the revenue. For the information of the shareholders, the directors annex a copy of the treasury minute upon the Government proposal for the development of the telephone system in the United Kingdom. The Bill to give effect to these proposals has received the the royal assent. The shareholders would perceive, from a careful perusal of the minute, that a new and important development of the company's business is imminent, and it may become desirable for the company either to acquire from the National Company, their business in Ulster, or to amalgamate with that company, the directors being of opinion that the telephone business of Ireland would be better developed if placed under one control and management. All the telephone companies, subsidiary to the parent company, have now, with the exception of this company, been absorbed by the National Company. In the event of an amalgamation being ultimately decided upon as preferable to a separate company for Ireland, the directors will endeavour to effect it upon such terms as shall be just alike to this company as to the National Company. The Post Office Department is authorised under the provisions of the Bill, to purchase from the telephone companies all trunk lines erected by them, and in these circumstances the directors expect that the outlay under this head, which has been considerable and largely made out of revenue, will be recouped and the revenue account thus placed on a satisfactory footing. Pending a final settlement with the National Company on the expiration of the patents and a possible readjustment of the relations of this company with them, and having regard to the probability of capital being immediately needed to meet developments, the directors consider it prudent to keep a substantial cash balance available. The directors do not, therefore, propose to pay the preference dividend, or any dividend on the ordinary shares at present, but the preference dividend being cumulative its payment is only postponed. The balance standing to the credit of the net revenue account, as upon December 31st, 1891, including the balance brought from last account, amounts to £5,362 10s. 11d., which the directors propose to allocate a follows: to the credit of the reserve fund, £369 19s. 10d. (being 10 per cent. of the net profits of the year), carrying forward the balance of £4,992 11s. 1d. to credit of the current year. An examination of the supplementary accounts to June 30th, 1892, will show that the balance to credit of net revenue at that date is sufficient, not only to pay the whole of the preference dividend, but leave a substantial sum for division amongst the ordinary shareholders. In conformity with the articles of association, one of the directors, Mr. Arthur Dudgeon, retires but is eligible for re-election. The auditor, Mr. John M. Kean, also retires but is eligible for re-election.

On Thursday (18th inst.) the thirteenth ordinary general meeting of the shareholders of the above-named company was held in the company's offices, Dame Street, Dublin, Mr. Alderman Dillon, chairman of the company, presiding.

The directors' report as above, and the statement of accounts having been submitted to the meeting,

The CHAIRMAN moved their adoption. In the course of his remarks he said it was a pleasant thing for the directors of a company numbering some 400 or 500 shareholders to find that their report was so satisfactory to the company that the attendance of the shareholders was almost *nil*. The company had been obliged, owing to their large expenditure out of the capital account, to postpone the payment of any dividend for the present. Out of this revenue account the company had constructed a trunk line connecting Dublin with Belfast. This, of course, absorbed the considerable revenue which was made during the year, and although they had in cash sufficient funds to pay a dividend, the directors thought it would be more to the advantage of the shareholders to postpone doing so for the present. He congratulated the shareholders on the progress which the company had made since the last meeting. The number of wires on December 31st, 1890, was 1,473, and at the present the number was 1,600—an increase of 127, and they had in hand orders for 27 wires, which were now in the course of construction. The company possessed exchanges in Dublin, Cork, and Limerick, and were opening others in Dundalk, Drogheda, and Balbriggan—towns already connected by a trunk wire. So soon as the Government carried out their proposal of connecting other cities, such as Waterford, Kilkenny, and Galway, and other important towns in the west and south of Ireland, the company intended to open exchanges in these places, and give them the facility of intercommunication, not only with towns in Ireland, but (so soon as the development of the system shadowed by the Post Office took place) with towns in England and Scotland, and ultimately telephonic communication with France and the Continent. The shareholders would be interested to know what the Government had proposed to do in connection with telephones. The Government proposed to connect every important town in Great Britain and Ireland with a cable for telephonic purposes, the same as the cable between London and Paris. They also proposed to allow call offices and exchanges, he hoped, to be established in all sub-post offices, so that in a short time the public might look forward to having a telephone office wherever a telegraph office existed. The Government would also allow telegrams to be sent to the telegraph offices by telephone for transmission. Hitherto, if a person wished to send a telegram, he had to take it to the telegraph office and deliver it there; but in a few weeks the users of telephones would be able, he hoped, to telephone their messages to the Post Office, and have it written down by the Post Office clerks, and transmitted by them. Those were very important developments, but they were only a portion of the change and improvements which the Government proposed introducing. If the Government proposed to work the telephone system with the same enterprise as they worked the telegraph system since the introduction of cheap telegrams, they would in a short time completely revolutionise the mode of communication in Great Britain and Ireland, and they would find people, instead of sending telegrams, would almost entirely adopt the system of telephoning. Everything, however, depended upon the good-will of the Post Office department towards the telephone system; but he had no doubt they would make the charges reasonable, particularly in Ireland, where the volume of business and other transactions was not large enough to warrant people paying heavy fees. He trusted that the charges would, on the whole, be so reasonable as at once to establish the success of the system.

Mr. GILBERT COCKBURN seconded the motion, which was adopted without discussion.

Mr. Alderman Dudgeon, C.E., was re-elected a director, and Mr. J. M. Kean re-appointed the auditor to the company.

The proceedings then terminated.

The Electricity Supply Corporation, Limited.—The Electricity Supply Corporation, Limited (London), on the 17th inst., declared an interim dividend for the half-year ending June 30th, 1892, at the rate of £5 per cent per annum on the ordinary share capital of the company, after payment of all interest on debentures.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 19th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £2,603.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation August 18th.	Closing Quotation, August 25th.	Business done during week ending August 25th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 –104	100 — 103	101⅜	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	47 — 48	47 — 48	46½	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½ — 88½	87½ — 88½	88⅜	87½
2,849,510*l*	Do. do. Deferred	Stock	10½ — 11	10½ — 10⅝	10⅝	10½
130,000	Brazilian Submarine Telegraph, Limited	10	10¾ — 11¼	10¾ — 11¼	11¼	11⅛
53,200*l*	Do. do. 5 p. c. Bonds	100	100 –103	100 –103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 –107	103 –107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ — 3⅛	2⅞ — 3⅛	3 1/16	...
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2¼	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3¼xd	2½ — 3¼xd	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	9¾ — 10¼	9¾ — 10¼	10⅛	...
$7,716,000	Commercial Cable, Capital Stock	$100	160 –165	160 –165	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅜ — ⅝	⅜ — ⅝	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 6xd	5½ — 5¾xd	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11⅜	...
6,000	Do. do. 10 p. c. Preference	10	17½ — 18½	17½ — 18½	17⅝	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼ — 3⅝	3¼ — 3⅝	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅝xd	11⅜ — 11⅝xd	11 1/16	11⅜
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝ — 15	14⅝ — 15	15	14 13/16
70,000	Do. 6 p. c. Preference	10	15½ — 16	15½ — 16	15 15/16	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 –109	106 –109	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 –112	109 –112	112	111½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15¼	15 1/16
78,300*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	103 –106	103 –106	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 –106	103 –106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 –111	108 –111	108½	...
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	102 –105	103 –106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 –105	103 –106	104½	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 –104	103 –106	104	103
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4⅞ — 5¼	4⅞ — 5¼	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅞ — 1⅛	⅞ — 1⅛	1 1/16	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛ — 2⅜	2⅛ — 2⅜	2⅜	2⅛
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅛ — 1⅜	1⅛ — 1⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10⅛ — 10⅜	10¼ — 10½	10⅜	10 1/16
180,042	Do. do. 6 p. c. Preference	10	15¼ — 15⅝	15½ — 15⅝	15 1/16	15¼
150,000	Great Northern Tel. Company of Copenhagen	10	18½ — 19	18⅝ — 19	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	107 –110	107 –110	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	6 — 7	5½ — 6½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	22⅜	21½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 –106	104 –106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42½	42
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16 — 3 9/16	3 7/16 — 3 9/16	...	...
10,000	Do. do. fully paid	5	5 7/16 — 5 9/16	5 7/16 — 5 9/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 –111	108 –111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6⅞ — 7¼	6⅞ — 7¼	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞ — 4⅞	4⅞ — 4¼	4⅞	4¼
15,000	Do. 6 p. c. Cum., 1st Preference	10	13¾ — 14¼	13¾ — 14¼	13⅞	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13 — 13½	13 — 13½	13 7/16	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	109 –111	109 –111	110½	110¼
250,000*l*	Do. (issued at 5 p.m., all paid)	...	109 –111	109 –111	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	5/16 — 5/16	5/16 — 5/16	...	...
9,000	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7½ — 8	7½ — 8	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞ — 8¼	8 — 8½	8 1/16	...
3,381	Submarine Cables Trust	Cert.	115 –120	115 –120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3⅛	3¼	...
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	42 — 44	44	43¾
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 –106	103 –106	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½ — 7½	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	100 –104	101 –104	103½	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	3 1/16	3⅜
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 –106	102 –106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	8⅜ — 9¼	8⅜ — 9¼	8⅞	...
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6½	6¼
30,364	Do. do. do. 5 p. c. Deferred	7½	2½ — 3	2⅜ — 3⅛	2⅞	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 –105	103 –106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 –105	103 –106	...	...
88,321	West India and Panama Telegraph, Limited	10	1 — 1½	1⅛ — 1⅜	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¼ — 9⅝	9¼ — 9⅝	9½	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	101 –105	101 –105	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 –125	123 –128	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 –103	100 –103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜ — 6¼xd	5⅜ — 6¼xd	5 1/16	5 1/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2⅛—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 102—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—£5 Preference (fully paid), 2⅛—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892)

THE BRITISH ASSOCIATION.

ON THE CLARK CELL.

By Dr. Kahle.

(Read before Section A, August 9th.)

In connection with the report of Prof. Glazebrook, I beg to call your attention to some researches I made, by order of the Physico-Technic Institute at Berlin, on Clark cells. The time is too short for communicating my measuring methods and results in full extent; I can only give you a short summary of the chief points.

I used in my researches Lord Rayleigh's H-form, the positive electrode being mercury once distilled, the negative an amalgam containing 90 parts of mercury and 10 parts of zinc. The last was filled in the vessel as a hot liquid, and solidified on the bottom. The paste, which covers the positive electrode, is made by grinding together mercurous sulphate, mercury, and a mixture of crystals and concentrated solution of zinc sulphate. No heat was used in preparing this paste. The mercurous sulphate was bought, and contained, according to chemical analysis, no foreign ingredients. The zinc sulphate was made basic by boiling with rods of metallic zinc; after cooling, the dissolved oxide of zinc precipitates, and with it the oxides of the metals more negative than zinc. For oxidising the ferrous sulphate, which is always present in commercial zinc sulphate, a small current was sent between two platinum electrodes through the boiling basic solution; the ferrous sulphate was changed by the generated oxygen into a ferric one, and fell out. The H-cells set up with these materials showed a great agreement in their electromotive forces; I never found a difference greater than $\frac{1}{10000}$th of a volt between the E.M.F. of any two of them.

The next point I studied was the influence of the impurities in the different materials composing the cell on the E.M.F., because on the one side it is well known that the smallest impurity of the mercury alters very distinctly the E.M.F., and on the other side the mercurous sulphate I bought never contained impurities of a remarkable amount, and different samples always had the same qualities; I only investigated, as the most important matter, the impurities of the zinc and its sulphate. It was found that the foreign ingredients of the zinc sulphate are of very little importance, and that only the presence of free acid in the above described cleaning process, the result of boiling with metallic zinc, alters the E.M.F. in a considerable degree. Among the impurities of the zinc only those caused by metals more positive than zinc are of importance; the zinc may contain considerable quantities of the negative metals without any alteration of the E.M.F. I suppose the impurities of the zinc are of greater importance. If we use it in the form of rods amalgamated on the surface, it seems to be a great advantage to dissolve the zinc in mercury, using it then as a solid amalgam.

The following are the values I found by a great deal of observations for the temperature coefficient of different forms of cells, measuring between 10 and 30° in rising and decreasing temperature. The figures here given are the mean values of some cells of the same form, treated in the same manner.

Form of the cell.	Temperature coefficient.	Mean difference between calculated and observated values of E.M.F.	Mean difference between the E.M.F. of the different cells and that of the mean of several H-cells used as standards.
		The unit being $\frac{1}{10000}$ of a volt.	
H-cell, set up in Lord Rayleigh's manner.	+ 0·000812 + 0·000013 (+ − 15)	12	+ 3
H-cell, the paste covering both electrodes.	+ 0·000774 + 0·000020 (+ − 15)	12	+ 7
A new form for researching purposes, the paste covering both electrodes.	+ 0·000791 + 0·000017 (+ − 15)	9	+ 9
The cell issued hitherto by the German Reichsanstalt.	+ 0·000806 + 0·000006 (+ − 15)	30	− 29

The mean value of the temperature coefficient, therefore, would be

0·000796 + 0·000014 (+ − 15).

Lord Rayleigh has given the following values for the two different cells he investigated:—

+ 0·000827 + 0·000018 (+ − 15)
+ 0·000740 + 0·000016 (+ − 15)

the mean being

+ 0·000783 + 0·000017 (+ − 15).

I suppose, for practical purposes, the value found by Lord Rayleigh and by me are identical.

The most important matter is to obtain the absolute term of the E.M.F. For that purpose I used a measuring arrangement, similar to Lord Rayleigh's. The current, which produces on the terminals of a known resistance a pressure equal to that of the Clark cell, was obtained by the silver voltameter. It was found that the same current deposits the more silver the more oxide of silver is dissolved in the solution of the nitrate. I made a solution of nitrate crystals, and boiled a part of it a long time with oxide of silver; the deposit gained with this basic solution was about $\frac{6}{10000}$ths greater than that with the original solution. Therefore using a certain number for the equivalent of silver, there will be a little uncertainty of some parts of 10,000 in measuring currents by the deposition of silver. Now as first shown by Prof. Schuster, and also proved by me by a large number of experiments, the deposit, when the voltameter is in vacuo, is about four parts of 10,000 greater than in ordinary air. But the absolute value of the E.M.F. is not touched by this fact, because making the electrolysis in this manner one has certainly to take a greater figure for the equivalent, and therefore the ratio between the unit and the measured amount of current remains the same. The following figures are given by taking 1 ohm = 1·063 S.U., and by assuming that a current of 1 ampère strength deposits in an hour 4·0259 ampères; the last figure exceeds that given by the Board of Trade only by six parts of hundred thousand. I found by some thirty experiments, the E.M.F. of the H-cells, set up with clean materials in the above described manner, as 1·4332 volt at 15°, and am sure that, when using the same arrangement of the silver voltameter, this value will be right by five parts in ten thousand if the equivalent is sure in this limit. If I express the value given by Lord Rayleigh for the cells of the original Clark's form in this unit, it is 1·4346 volt at 15°. Lord Rayleigh finds the E.M.F. of the H-cell a few ten thousandths of a volt greater than that of the old form. Therefore, it would, perhaps, be 1·4350 volt at 15°.

Recently, Prof. Glazebrook has made a new determination, and finds in the above fixed units as E.M.F. of the original Clark cell, 1·4342 volt at 15°. He has also compared H-cells set up by me and now brought to England, and finds their E.M.F. by $\frac{8}{10000}$ths of a volt smaller than that of the original form. Therefore, the E.M.F. of the H-cell is 1·4338 volt at 15°. This last value and that found by me, are in good agreement. It is remarkable that the anodes and cathodes in my voltameters are much smaller than those in the English ones.

It may be mentioned here that the mean E.M.F. of four H-cells set up in the same manner as before, but containing in accordance with Prof. Carhart's directions, a solution of sulphate of zinc, saturated at 0°, was found as 1·442 volt at 15°, using the same units as above.

It only remains to give some directions on the best form of Clark cells. I suppose it will be good to distinguish such cells which shall remain as standards in the laboratories and are used by their manufacturer, and such ones which shall be used for practical purposes. These do not need to have the same degree of accuracy, but they must be able to be carried about. In the Board of Trade's memorandum, the original Clark cell is adopted as the standard, but, I suppose, Lord Rayleigh's H-form gives more accuracy and is easier to set up. In the old form, all the parts of the zinc rod are not in saturated solution, and, therefore, the value of the E.M.F. will be a little uncertain. Another disadvantage is, that parts of the zinc rod may fall down in the mercury, and will so produce a considerable change of the E.M.F. On the other hand, the electrodes of the H-form are always in concentrated solution, and there is no possibility of parts of the negative electrode coming over to the positive one. I have set up about sixty H-cells, and have found no difficulty, when using carefully cleaned materials, to keep the difference of the E.M.F. of the single cells under a ten-thousandth of a volt.

To construct cells for practical purposes, which will bear transport, the most simple way is to separate the two electrodes by a porous division. I can show here such a cell constructed by Dr. Feupner and issued hitherto by the German Reichsanstalt. The positive electrode is an amalgamated platinum plate with the surrounding paste in a porous vessel of clay. The zinc rod forming the positive electrode is on the upper part protected by a glass tube, the lower part is blown rectangularly and covered with crystals of sulphate of zinc. The whole glass vessel is filled with a concentrated solution of this salt. The E.M.F. of such cells is about $\frac{1}{10000}$ths of a volt higher than that of the H-cells. The agreement of different cells of this form is quite sufficient for practical purposes; the difference between the E.M.F. is always smaller than $\frac{1}{1000}$th of a volt. The only disadvantage of this form is, that its E.M.F. does not follow quickly the alterations of temperature; but I suppose one could improve that by diminishing the size of the cell.

We endeavoured in the Reichsanstalt to get portable Lord Rayleigh's H-form on account of its good qualities, and to do this without introducing foreign substances as porous divisions. The investigations in this direction are not yet finished, but I can show you here a cell which was constructed for this purpose and seems to be good. The positive electrode is formed by an amalgamated platinum plate fixed on a wire of the same metal, which is melted in the bottom of one of the two tubes forming the vessel. The negative electrode is formed by the 10 per cent. zinc amalgam solidified on the bottom of the other tube, and also connected with a platinum wire melted in the glass. The whole vessel is filled with the paste and closed by a glass stopper perforated by a thermometer of which the bulb is within the vessel. Such a cell can be inverted without any danger and is suitable for transport. The E.M.F. is about $\frac{1}{10000}$th of a volt smaller than that of the H-cells; the agreement between the E.M.Fs. of different cells constructed in similar manner does not

exceed $\frac{2}{1000}$ths of a volt. But before using such cells for practical purposes they must be observed for a longer time till one is sure that their behaviour will not be altered by age.

These are the principal results gained during the last time in the Reichsanstalt on this matter. Some of them will be already known here, but I hope to have given new proof that the Clark cell is a very accurate standard for E.M.F. and a good standard for practical purposes.

NATIONAL PHYSICAL LABORATORY.

(Read before Section A, August 8th.)

PROF. SCHOUTE, of Groningen, gave a description of the physical laboratory there, which had been built with a view to carrying out researches in the most accurate manner possible. The chief points aimed at were:—(1.) The elimination of disturbances from traffic; (2) that the free access of sunlight on all sides should not be obstructed; (3) that the foundation should be firm, but without transmitting vibration; and (4) that the presence of any iron in the building should be avoided.

Prof. LODGE, F.R.S., then opened a discussion on the desirability of creating a national physical laboratory.

Prof LODGE said a science in its infancy might be, and must be, grappled with by the scientific amateur, or at any rate, by the isolated individual to explore new and savage territory. As a science reached the stage when minute accuracy became possible and desirable the labours of the amateur in those branches became increasingly difficult and inefficacious. A great weight of learning was now no longer an impediment, but an essential. The free and amateur way of cultivating science had its advantages, but it had some disadvantages. Some men could and always would work best in the old way. Others could do better as head of a good establishment, with an organised staff and thorough equipment. For these latter men, so far as physics was concerned, we had no provision in England. In the British Isles other subjects were not so ill-provided as was physics. Astronomy, natural history, biology, and geology, were well-equipped institutions. But for physics, what was there except the old Universities, the new university colleges, and a teaching college at South Kensington? Of the work done by such bodies it was impossible to speak too highly, but he urged that there were very many investigations for which they were unsuitable, and which they could only undertake at disproportionate labour and sacrifice. The University and colleges had plenty of work lying to their hand, and they stood intermediate between the amateur on the one hand, and the highly-equipped Reichsanstalt, the Bureau des Poids et Métiers, or the National Physical Laboratory on the other. There was much work for which it would be disgraceful to use our greatest men. A great number of precise and accurate observations could only be carried out by the patient and continuous labour of a trained and competent observer for a year or two. For many such trained and competent observers places would be found in the national laboratory. They need not be men of genius; they must be men of precision, of system, and ability. Such men were not, indeed, common, but there must be hundreds of them for one great man of genius. They were sound, thorough workers, but they wanted a leader. Let them utilise these men and not waste them; establish a great national laboratory where congenial and fruitful work could be found for them, and there they would gradually find their level. In speaking of the work that should go on in such an institution, he brought as an example the Cavendish Laboratory, at Cambridge, where Lord Rayleigh, Mr. Glazebrook, and other men reared in that splendid University were working. All these things now going on in various parts of the island were more appropriate to a central or Government institution, with every possible appliance and aid to accuracy, with absolute standards ready for use, with rooms which could be set aside to a special purpose for several years, or, if necessary, for several centuries, and a staff of skilled assistants. An investigation in progress need not then be dropped by reason of lapse of interest on the part of the investigator or his decease or removal. The staff would be immortal, and any research determined on and ordered by the head or by the governing committee might go on for precisely as long as their judgment decided to be right. The classes of work appropriate to the national laboratory were: (1) extremely accurate determinations of fundamental quantities; (2) determination of physical constants and properties of materials; (3) maintenance of standards and issue of the verification of stamped and certified copies of the same for scientific and industrial use; (4) continuous record of certain phenomena supplementary to, but not necessarily interfering with, the similar work of Greenwich and Kew; and (5) the undertaking of certain determinate lines of research,

Mr. GLAZEBROOK, F.R.S., called attention to some points which he had come across in his work at the Cavendish Laboratory, and which ought, in his opinion, to be matters for a national laboratory to take up. These were—first, the fact that the testing of coils and comparisons of standard could only be carried on at odd moments, and when no great delay was caused. In a national laboratory this could be done systematically and expeditiously. Again, the question of secular changes in standards called for continuous and close observation.

Prof. VON HELMHOLTZ gave an account of the formation of the Reichsanstalt, of which he is the director. He stated that the funds disposable for the work of the institution were about £2,500 per annum, exclusive of salaries.

Prof. RUCKER, F.R.S., called attention to the inefficiency of Kew for very accurate work, unless purely magnetic. He hoped that if the Government took the matter up there would be no diversion into the new channel of the meagre funds which they devote at present to research work. He would be sorry to see teaching and research divorced, but the experience of Germany showed that there was no risk of it at present. With these provisions, he saw nothing but good in the proposal.

Other speakers followed, and most spoke of the desirability of a National Physical Laboratory.

WAVE PROPAGATION IN MAGNETIC MATERIALS.

By PROF. FITZGERALD.

(Read before Section A, August 10th.)

TAKING the particles as a set of magnets held in place by one another's mutual attractions, and assuming as a first approximation that the moment on any needle is proportional to the sum of its own and its immediate neighbour's rotations, then the velocity of propor-tion of a wave is given by

$$v = 2\,n_0\,\lambda\cos\frac{\pi l}{\lambda}$$

where n_0 is the frequency of vibration of each magnet when its neighbours are fixed, λ is the length of wave generated, and l is the distance between the centres of neighbouring magnets, and to determine the frequency corresponding to a given wave length, we have

$$n = 2\,n_0\cos\frac{\pi l}{\lambda}$$

From this we see that n cannot be greater than $2\,n_0$, and that in that case $\lambda = \infty$, while that for smaller values of n we have the wave length decreasing until $n_0 = 0$, when $\lambda = 2l$, which is the minimum wave length. This last is obvious, because when the magnets are swung very slowly from side to side, each takes the phase opposite to its neighbour and consequently $\lambda = 2l$.

Thus it appears that the wave length will be very small unless n is comparable with n_0.

In order to calculate n_0, we may estimate roughly the quantities involved. If we take each magnetic particle to have $l = 10^{-7}$, and if we assume such strengths of poles that the lines of force per sq. cm. from them would be 1,000, we can estimate for a material whose density is 7 the moment of inertia of its elements, and the moment of each as a magnet, and thus I have very roughly estimated the time of vibration of each element, and find $n_0 = 1{\cdot}6 \times 10^8$. If the elements are estimated as smaller, this frequency will be much increased, proportionally to the 2nd power of the dimensions, so that if the size of the molecules were 10^{-8}, the frequency would be about 10^{10}. If, however, the strength of the poles decrease, there will be a corresponding decrease in the frequency, so that we must not take the calculation as anything but *very* rough indeed. It would appear, however, that frequencies comparable to those of Leyden jar discharges might produce waves of measurable wave length, and that ones of a frequency comparable to that of light would probably not be propagated at all.

This agrees with Prof. Dewar's recent observation that light is sensibly completely polarised by liquid oxygen, a transparent magnetic medium, and with the fact that a strongly magnetic medium like iron seems not to have any very obviously peculiar properties in respect of the reflection of light, except those very minute, and consequently, in all probability, secondary phenomena, due to its being magnetised, and which Mr. Kerr so wonderfully discovered.

It would also account for the fact that Leyden jar discharges are not too rapid to create absorption of energy by iron, and might lead us to expect that possibly liquid oxygen itself may have a corresponding powerful absorbing power for some very long waves, although it is so good a non-conductor.

It also accounts for the want of success that has attended attempts to measure, by interference, the rate of propagation of waves of low frequencies in iron, for the length of such waves becomes comparable with the inter-molecular distances, and so out of reach of the means of observation used, the velocity of propagation being very low.

These considerations would also lead one to expect that the elementary magnets could easily follow much more rapid magnetisations than occur in transformers, without any sensible change in the nature of the law of magnetisation. This naturally leads to the question as to how far the magnetic motions may be damped, because it may very well be that there is no free period of vibration, and in that case this investigation would fail. A comparatively slight damping of motion would stop such rapidly vibrating elements.

This investigation only deals with *small* magnetising forces; the large ones usually dealt with in transformers are propagated much more like an explosion than like a wave.

ON THE DIELECTRIC OF CONDENSERS.*

By W. H. PREECE, F.R.S.

(Read before Section A, August 9th.)

ARTIFICIAL cables are very useful adjuncts to the laboratory of the telegraph engineer. They not only enable him to experiment at his leisure, but they form very useful means to test and compare high speed and delicate telegraph apparatus, and especially telephones. I have one, made some years ago, which has been in incessant use, composed of 54 inductionless coils of insulated copper wire, each giving 33 ohms resistance, and having a condenser of 1 microfarad capacity at the juncture of each pair of coils, and one at the termination of the series. This represented a circuit of a total capacity (K) of 54 micro-

* Lord Kelvin proposes to call this useful instrument a "Leyden," because the term "condenser" is applied to other more appropriate mechanical and physical apparatus.

farads and of a total resistance (R) of 1,782 ohms. The K R being 96,228. This was equivalent to an ordinary submarine cable of 162 nauts length. It was not sufficient for our growing wants, and another similar set was recently made, but it did not give the same results. The resistances were exactly the same, but the individual capacities differed. This difference, of about 5 per cent., was, of itself, of no practical consequence for the particular purpose for which the cable was constructed, but on carefully comparing the two "cables" with telephones, it was found that with the same nominal K R the one gave 30 per cent. better results than the other. This was a surprising and unexpected result. I thought it might be due to inductance, but none, neither *self* or *mutual*, could be detected.

The insulation, taken after one minute's electrification of each, was:—

Old cable 172·8 megohms per naut.
New „ 82·8 „ „ „

so that the difference was in favour of the old one. But the electrification of the new one was much less than that of the old one. The difference in the reading between the first and second minutes on the former was $\frac{1}{10}$th of that of the latter.

Each cable was then rapidly charged and discharged 1,200 times, at varying rates, with an E.M.F. of 40 volts, and the cumulative remaining charge in each case read by reflection on a Thomson galvanometer. This was done by passing a 10-feet length of perforated slip through a Wheatstone's automatic transmitter. The following are the results:—

Number of discharges per second.	Discharge.		Percentage difference.
	New.	Old.	
20	46	28	39
40	86	55	36
80	151	100	33
120	200	136	32
160	237	168	29

This clearly shows that the effect is due to absorption. Electrification, polarisation, and absorption are phases of electrolytic work done by the current upon the dielectric. The material itself or the impurities contained in it being slightly decomposed by the leakage current, a counter E.M.F. is set up, which increases the apparent resistance (electrification); it gives a current of discharge reverse to that of charge (polarisation); it absorbs a quantity of electricity, the undissipated part of which is recovered as a discharge current. The condenser acts, in fact, like a secondary cell.

We are now using better paper than formerly—that made from the best linen rags, thinner tinfoil, and better wax—the best refined unadulterated white paraffin, having a melting point of from 125° to 128° Fahr. Resin was formerly mixed with the wax, and when hot and liquid, it was painted on the paper with a brush. The paper is now thoroughly dried, and well saturated with wax, by soaking under pressure, so as to get rid of all the moisture. Hence there is less electrification and less absorption, and hence the difference. In the old type of condenser we observed a variation of capacity, due to temperature; but in the new type this has disappeared. This effect of absorption on the effective capacity of the condensers, and of insulated conductors, is new to me, and as it may be new to many others, I have thought it to be of sufficient interest to bring it before Section A.

It is a new term to be added to the equation of energy of compound circuits, and it has evidently a material influence upon the retardation of signals in long submarine cables. It has an equally important influence on the efficiency of telephone circuits, and it accounts partially for the great difference in my K R law between the observed effects of aerial and those of subterranean or submarine conductors. The former are always much superior to the latter. This would be due to the absence of polarisation in air as well as to other electro-magnetic and electrostatic causes. No work would be done on the molecules of air, no energy would, therefore, be absorbed, and no retardation of currents from this cause would ensue. An air dielectric is clearly the "Holy Grail" of the electrician.

NOMENCLATURE OF UNITS.

(*Concluded from page* 194.)

At the conclusion of Dr. Lodge's report, Dr. Hopkinson said he thought they ought to be exceedingly cautious in the adoption of new names for units, especially when science was in the state of rapid development in which electrical science was at the present time. In some of the proposals of Dr. Lodge they had a very good illustration of the somewhat premature adoption of particular names for particular purposes, for he (Dr. Lodge) now proposed to alter the names which had been already adopted. It seemed to him they ought to be still more cautious in altering the names already fixed. Looking through the suggestions of Dr. Lodge, they found, first of all, that he proposed to alter the meaning of the word farad; microfarad was to be called farad. That was open to the objection that whenever the term was used they would always have to refer to the date at which the paper had been written in order to know what the signification of the term was. In that case, of course, they might very easily obtain from the context what was meant; but it was not inconceivable that a case might arise where it would be difficult. That, to his way of thinking, would be a great objection to the alteration of the meaning of the term, although it might be clear that it was desirable to do so. In the future they might be able to manufacture cheaply condensers of capacities comparable with the farad, and was it not possible that they might get liquid condensers of considerable capacities? As a matter of fact they could make such condensers now, the only objection was that they were wasteful. That difficulty might be got over in the future; if it was, they would have condensers of a capacity of one farad, if Dr. Lodge was to alter the signification of the terms at present used, they would then have megafarads which would be as microfarads are now. With regard to the magnetic circuit Dr. Lodge had called attention to the fact that there were three names used for the coefficient of self induction, the secohm, the quadrant, and the henry. For his part he preferred the name quadrant, which was the name purely and simply for a length, the coefficient of self induction was a length; why then should they call it otherwise than a length? There was another proposal, that was to use the "weber" as the unit of total induction, that would be quite unobjectionable if the "weber" had not been used in another signification. It was not so very long since that it was used as the unit of current, and if they were to give to that name a new signification they would always require to know the date of the paper in which the word occurred. Though one would willingly do honour to the name of Weber, he felt that if they were to adopt a name for total induction they should use some other name. The last point upon which he would remark was the proposal to adopt the word "mo." It was not that he objected to the name, but he thought it was a very doubtful name. Scientific men might go the length of manufacturing mongrel names, compounded out of two or three things without doing any great violence to their feelings, and might submit themselves to the hypercriticism of linguists, but there was a point beyond which they ought not to go, and if one could imagine the sensitive feelings of linguistic gentlemen being harrowed to the extent they would be by words turned inside out, he thought they should hesitate, and choose some other word for the reciprocal of resistance of conductors.

Mr. W. H. Preece said that Dr. Hopkinson had forgotten the fact that the word "mo" was almost historical. It had been proposed some years ago by Sir Wm. Thomson to represent the reciprocal of resistance; it was in very frequent use, and there were mhometers in use. He, the speaker, did not object to the word, but to the way in which Dr. Lodge spelt it. It was a very bad habit indeed to drop h's; "mho" had a real significance, and it conveyed an idea. He had no objection to the transference of the term "farad" from the very large unit originally proposed to the smaller one proposed by Dr. Lodge. It happened, fortunately, that in literature and papers generally the index, ϕ, was used to indicate the unit of capacity, and it mattered little whether that be called microfarad or farad. He had never known the name farad used, but if in the dim future they were to deal with immense quantities, it would be just as easy to use the megafarad as they did the megohm. Dr. Lodge had said that he (the speaker) had spoken favourably of that change; he did so because it was consequent on another change, which was, to his mind, of far greater importance than any proposal of Dr. Lodge; that was that the value of the unit E.M.F. should be raised to 10^9. If they were to raise the unit of E.M.F. by one more power, they would at once place the units used most frequently on the same line as the C.G.S. absolute system. Dr. Lodge had proposed gaussage and weberage, but he was obliged to divide 4π by 10, and everybody who entered into magnetic calculations in metallurgy and electro-chemical, knew that he was incessantly worried by this power of 10. Although he did not now propose the alteration, he would next year, at the Chicago congress, make a distinct proposal that the unit of E.M.F. should be increased. Until they had the result of that congress the final discussion would have to be postponed. He therefore only agreed with Prof. Lodge in the proposal that the term farad should be applied to the present microfarad.

Mr. Du Bois agreed with previous speakers as to the undesirability of naming the new magnetic units indicated by Dr. Lodge. He was sure the Continental physicists and engineers would not adopt them.

SLOW OSCILLATIONS PRODUCED ON DISCHARGING ELECTRIC CONDENSERS OF GREAT CAPACITY.

By James H. Gray, M.A., B.Sc., International Exhibition Scholar, Glasgow University.

(*Read before Section A, August 6th.*)

About the end of last winter Lord Kelvin asked me to try to obtain oscillations, on the discharge of a condenser, which would be slow enough to be observed by means of a mirror galvanometer. For that purpose I made use of a set of large condensers (total capacity about 140 microfarads) which are in the Physical Laboratory of Glasgow University. The capacity of the condensers being so large, it was thought that it would be possible to make the time of oscillation as large as one second, and yet keep the ratio of damping sufficiently near unity as to allow the first few oscillations to be observed.

Taking the well known equation for this problem—

$$\frac{d^2 q}{d t^2} + \frac{R}{L}\frac{d q}{d t} + \frac{1}{C L} q = 0,$$

where q = quantity of electricity in the condensers at time t;
R = resistance of the coil through which the condensers are discharged;
L = self-induction of the coil;
C = capacity of the condensers;

we have two solutions according as $4L \lessgtr C R^2$.

In the first case, the discharge is continuous; in the second, $4L > C R^2$, with which we have to deal at present, the discharge is oscillatory, the oscillations dying down more or less rapidly.

The solution for this case is

$$q = Q e^{-\frac{R}{2L} t} \frac{\sin(\alpha t + \beta)}{\sin \beta};$$

where Q = quantity of electricity in the condensers at starting;

$$\alpha = \sqrt{\frac{1}{CL} - \frac{R^2}{4L^2}};$$

$$\tan \beta = \frac{2L}{R} \sqrt{\frac{1}{CL} - \frac{R^2}{4L^2}}.$$

The current at any time, t, is

$$i = \frac{Q}{\alpha CL} e^{-\frac{R}{2L} t} \sin \alpha t.$$

From these equations we see that the maximum values of q and i occur at intervals of time $\frac{\pi}{\alpha}$, and are—

(for q) $\quad Q, \quad Q e^{-\frac{R\pi}{\alpha L}}, \quad Q e^{-\frac{2R\pi}{\alpha L}}$, &c.

and (for i)

$$\frac{Q}{\alpha CL}, \quad \frac{Q}{\alpha CL} e^{-\frac{R\pi}{\alpha L}}, \quad \frac{Q}{\alpha CL} e^{-\frac{2R\pi}{\alpha L}}, \text{ &c.}$$

the ratio of damping in both cases being $e^{-\frac{R\pi}{CL}}$. If, therefore, this ratio $e^{-\frac{R\pi}{\alpha L}}$, be nearly equal to unity—that is, if $\frac{R}{\alpha L}$ be very small—it will be possible to obtain a considerable number of oscillations before they die down. We have, however, for the time of oscillation

$$T = \frac{2\pi}{\alpha}.$$

If we make T large, α must be small, and therefore $\frac{R}{\alpha L}$ large, unless $\frac{R}{L}$ is small. The result, therefore, of making T large is to make the oscillations die down very quickly, unless the resistance of the discharging circuit be small compared with the self-induction.

If the time of an oscillation be very small, however, the first few hundred oscillations will have almost equal amplitudes, but, in order to detect them, it would be necessary, as in the experiments of Feddersen, Blaserna, and others, in whose tests the frequency was about 10,000 per second, to use a Wheatstone's revolving mirror, or some similar method.

In the trials made last winter in conjunction with Mr. E. T. Littlewood, M.A., B.Sc., a number of coils were tried, but in none of the cases was the resistance small in comparison with the self-induction. The coils which gave the best results were originally the field magnets of a dynamo. The magnets were of the ordinary horseshoe shape (fig. 1), the coils being wound on the poles.

The length of each coil was about 28 centimetres, the outside diameter 18 centimetres, the inside 10 centimetres. On each coil there were 7,000 turns—45 lbs. of No. 20 (B.W.G.) copper wire. The resistance of each coil was 95 ohms.

One or both of these coils was always in the discharging circuit, other coils having different resistances and self-inductions being joined in series to find how they altered the nature of the discharge. In no case was it found possible to obtain more than the first two or three oscillations.

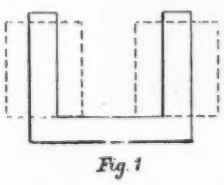


Fig. 1

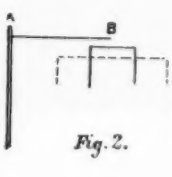


Fig. 2.

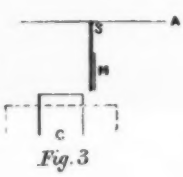
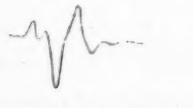
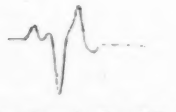


Fig. 3



One magnet coil only (large self-induction) in discharging circuit.

CURVE 1.



One magnet coil, and 10 ohms (wound anti-inductively).

CURVE 2.

One magnet coil and 100 ohms (wound anti-inductively).

CURVE 3.

It must be clearly understood that it was not intended that the apparatus used should give quantitative results. It was merely for the purpose of demonstrating experimentally that there were oscillations on discharging condensers under certain conditions, and of obtaining very slow oscillations. The complications introduced by hysteresis, by Foucault currents in the iron, heating, &c., although preventing the apparatus from being used for quantitative purposes, in no way interfered with their efficiency for the purpose required.

It was found difficult to adjust the mirror galvanometer to make it detect the oscillations, but they were observed by means of a telephone of small resistance, and distinctly seen when, at Mr. Littlewood's suggestion, a thin strip of sheet iron, A B (fig. 2), was placed with one end, B, about five millimetres from one pole of the electro-magnet so as to vibrate freely, the other end, A, being fixed.

The condensers were charged to a potential of 95 volts. At each semi-oscillation the strip was strongly attracted. To prove that this was not due to the free period of the strip, it was clamped at different distances from B, and this was found to make no difference in the time which elapsed between each attraction as long as the resistance and self-induction of the circuit remained constant. When, however, the resistance was increased, the self-induction remaining unaltered, the time of oscillation was correspondingly increased. In order to examine the effects carefully, the strip of iron was caused to record the attractions on a sheet of sooted paper, which moved uniformly in a horizontal direction. The magnet coils were first taken singly, and then together. Then, in both cases, coils of different resistances, some wound anti-inductively, some inductively, were connected in series with the magnet coils. The tracings obtained, although too complicated, for the reasons stated above, for obtaining actual quantitative results, clearly indicated the correctness of the theory, showing that increase of resistance or of self-induction increased the time of oscillation.

In order, however, to prove that there was an actual reversal of current, it was necessary to use a permanent magnet, instead of the strip of soft iron, as a vibrator. The recording apparatus of the syphon recorder was therefore used, but on account of its delicacy it was found not to be well suited to the rough apparatus employed. A long, thin, cylindrical magnet was then tried, it having been strongly magnetised so that the reversals in the discharging coil would not cause its magnetism to be reversed. The arrangement was as in fig. 3.

The magnet, M, was fixed at one end to a thin spring, S, which was attached to a support, A. The magnet was free to vibrate just over one pole of the electro-magnet, C. By affixing a small pointer to M, the vibrations were recorded on the sooted paper, which moved at about 2·5 cm. per second.

One magnet coil and 145 ohms (wound inductively).

CURVE 4.

One magnet coil and 293 ohms (wound anti-inductively).

CURVE 5.

Both magnet coils in discharging circuit.

CURVE 6.

Both magnet coils and 10 ohms (wound anti-inductively).

CURVE 7.

Both magnet coils and 100 ohms (wound anti-inductively).

CURVE 8.

Both magnet coils and 145 ohms (wound inductively).

CURVE 9.

Both magnet coils and 1,000 ohms (induction small).

CURVE 10.

Free swing of magnet.

CURVE 11.

The accompanying curves show the effect of substituting different resistances in the circuit, and, neglecting the effect of hysteresis and other disturbing causes, give the compound harmonic curve, composed of the electrical oscillations and the free vibration of the magnet, the latter of which is shown alone in curve 11.

PHOTOGRAPHS OF ELECTRIC DISCHARGES.

BY A. A. CAMPBELL SWINTON.

(Read before Section A, August 6th, 1892.)

I MUST first apologise for some want of novelty in the subject matter of this paper. When I originally undertook to read it, I was under the impression that the photographic figures with which it deals were entirely new. I have, however, since learnt that similar figures have been produced by others, notably by Mr. J. Brown, of Belfast, who described and illustrated some of his results in the *Philosophical Magazine* for December, 1888.

However, some of the figures that I have obtained differ considerably from those illustrated by Mr. Brown, having been produced under dissimilar conditions. Moreover, some additional experiments which I have made lead me to differ from Mr. Brown's conclusions as to the exact nature of the agency that is productive of the impressions. I trust, therefore, that I may be pardoned in bringing the subject to the notice of this section of the Association, especially as the photograph will, I hope, prove interesting to those who have not seen similar examples before.

The figures exhibited were all obtained without the employment of any camera or lens, and produced by merely causing the electric dis-

charges to take place across the sensitive surface of ordinary argentic gelatino-bromide dry plates.

When single positive or negative discharges are desired, the photographic plate, the back of which is covered with a sheet of tinfoil, is placed between the two discharging points, and the strength of the discharge is regulated, so that while it shall spread over as much of the plate as possible, it shall not pass over the edge. The tinfoil performs a double function; it does away with the spark on the back of the plate, which would otherwise occasion a confused figure, and it also assists in causing a uniform spreading out of the discharge. It does not seem to modify the character of the figure produced in any way. It, however, affects its form, since if the foil be smaller than the plate, the discharge seems to have a great disinclination to extend itself beyond the edge of the foil, but would even curve round to avoid doing this.

obtained with some difficulty by carefully turning the handle till a discharge took place, and then immediately arresting its movements. In both cases where the induction coil was used, a single discharge was produced by making the circuit before the insertion of the plate between the points, and breaking it once only by means of a hand operated mercury contact breaker.

Photograph No. 1 represents the figure produced by a single positive discharge from the induction coil.

No. 2 is a single negative discharge from the same.

The entirely distinctive character of figure produced by positive and negative discharges respectively will be observed.

It may be remarked that discharges obtained from the Wimshurst machine are exactly similar in character to the above, but when the Tesla coil was used, a distinctive form of figure having both positive and negative characteristics was produced.

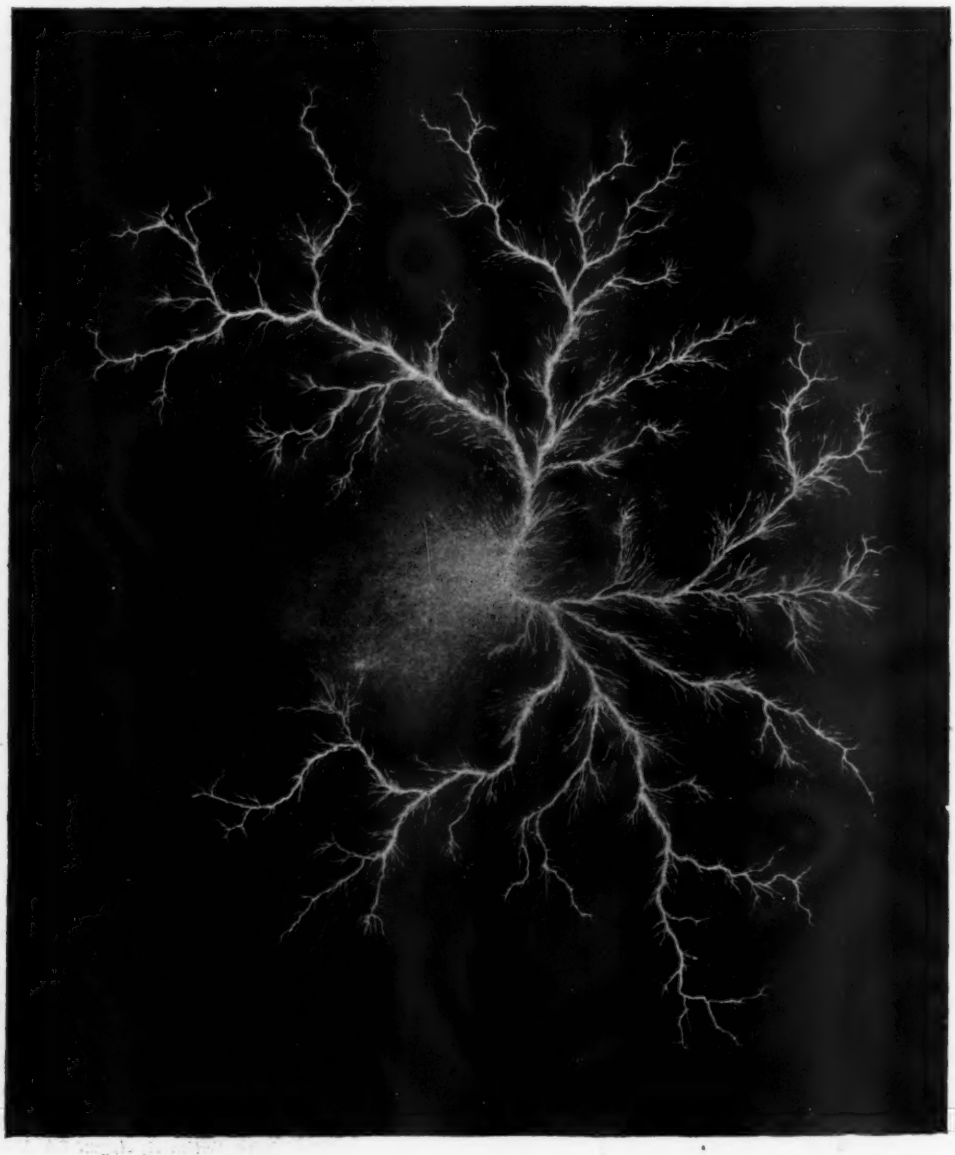


FIG. 1.—POSITIVE DISCHARGE.

The arrangement adopted when it is desired to obtain both positive and negative discharges simultaneously on the same plate, and when connecting sparks from positive to negative are desired, is similar, only in these cases the two discharging points are both placed on the film side of the plate.

For producing the discharges I have employed three different arrangements.

1. A "Wimshurst" machine of the ordinary construction, with four small Leyden jars capable of giving 5-inch sparks in air.

2. An "Apps" induction coil, capable of giving 10-inch sparks in air.

3. A "Tesla" high frequency coil operated by means of Leyden jars discharging across an air gap. The jars being charged by means of the above-mentioned induction coil.

In the case of the "Wimshurst" machine, single sparks were

In the paper already alluded to, Mr. Brown has raised the question whether the results are due to a photographic effect of the luminosity of the spark, or to some more direct "electrographic" action of the discharge upon the sensitive film. Mr. Brown favours this latter view, and considers that the actual amount of light evolved is insufficient for the purpose.

In order to clear up that point, I have made several experiments. Covering the film with a thin disc of ebonite, I made a spark into the centre of the latter. No effect was produced by the discharge until it had reached the limits of the opaque disc. Next, I repeated the experiment with a thin transparent disc of mica, in place of the ebonite. In the result the mica appears to have behaved as though practically non-existent.

In case the different electrical properties of mica and ebonite might have affected the results, similiar experiments were made with

discs of non-actinic ruby glass, and clear glass. And it was found that while the ruby glass behaved as did the ebonite in stopping all action until the edge of the disc was passed, the clear glass allowed the action to take place all over the plate, though on account of the thickness of the glass, and the consequent intervening distances between the spark and the film, the details of the figure produced were somewhat blurred and indistinct. Subsequently using very thin glass, this indistinctness was almost entirely eliminated.

From these results it seems quite clear that the action is due to flowing from the glass to the electrodes, and drawing or sucking from all portions of the plate.

Another point to be noticed is the remarkable similarity between some of the figures and organic forms, such as some kind of sea-weed in the case of the positive, and feathers, or branches of palm leaves in the case of the negative. The figures, in fact, present another curious instance of the remarkable manner in which under favourable conditions inorganic matter will assume the structural forms generally associated with organic life.

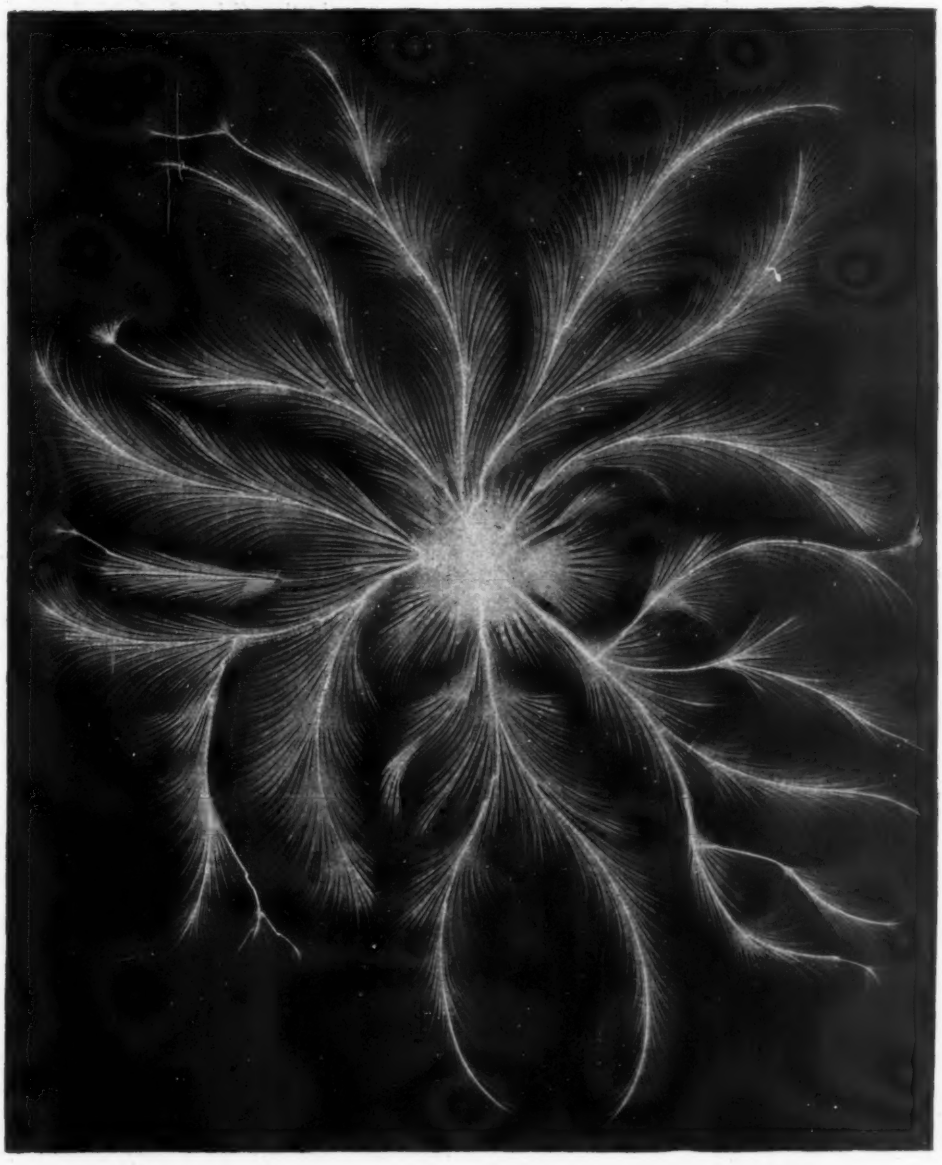


FIG. 2.—NEGATIVE DISCHARGE.

the ordinary photo-chemical effect of the light produced by the spark, which though feeble in intensity to the eye, is blue, and must be remarkably actinic.

These experiments also go to prove that the general character of the positive and negative figures are not dependent upon the gelatine film of the photograph plate, but are invariable for insulating surfaces, such as glass and mica. That this is so is proved by the fact that although by reason of the extreme relative brightness of the main arteries, it is very difficult to see the lesser emanations in the spark itself, still I have been able to catch a glimpse of those of both positive and negative characters, by carefully watching the discharges over a plain sheet of glass in a perfectly dark room.

It is noticeable that while in the negative figures the main arteries show a decided tendency to form straight lines or sweeping curves, while the lesser emanations form very regular curves, diverging in frond-like form from the arteries, there is apparently no such tendency in the positive figures, which are entirely irregular.

In fact, while the negative figures point to something of the nature of momentum in the discharge, and give the idea of a stream issuing from the electrodes, and splashing over the surface of the glass, positive figures, on the other hand, seem more nearly allied to streams

NEW PATENTS—1892.

14,217. "Automatic electric heat alarm." F. S. PALMER and L. H. DESISLE. Dated August 6th. [Date applied for under Patents Acts, 1883, Section 103, January 9th, 1892, being date of application in the United States.] (*Complete.*)

14,229. "Improvements in incandescent electric lampholders." H. STONE. Dated August 6th.

14,239. "Improvements in electricity meters." G. HOOKHAM. Dated August 6th.

14,250. "Improvements in secondary batteries." S. A. ROSENTHAL and V. C. DOUBLEDAY. Dated August 6th.

14,256. "Improvements in cable connection for lightships." H. A. C. SAUNDERS. (Communicated by R. Greey, Malta, and W. H. Cottrell, Syra, Greek Islands.) Dated August 6th.

14,309. "Improvements in electricity meters." F. TEAGUE, E. F. MOY, and J. A. ILIFFE. Dated August 8th.

14,360. "An electric bell." G. DAVIS. Dated August 9th.

14,363. "Improvements in the method of and apparatus for transmitting and receiving time signals over main and local electric circuits." W. F. GARDNER. Dated August 9th. (*Complete.*)

14,395. "Improvements relating to electric furnaces for the treatment of auriferous sulphide ores and for other purposes." J. W. CANN and R. E. COMMANS. Dated August 9th.

14,410. "Improvements in combined fishing and lifeboats to be propelled by hydraulic mechanism actuated by steam, electric, or other known power." J. F. GREEN. Dated August 9th.

14,423. "Improvements in electricity meters." A. WRIGHT. Dated August 10th.

14,481. "Improvements in decorating chandeliers, gasoliers, lamps, and electric light fittings." H. HATELEY. Dated August 11th.

14,489. "Improvement in governing devices for electro-motors." T. CUTTRISS." Dated August 11th.

14,512. "An electric combination street alarm box for fire, police, and other purposes." H. BINKO. Dated August 11th.

14,516. "A new or improved electric or other flashing signal lamp." H. W. C. BAKER. (Communicated by L. C. L. BAKER, H.M.S. *Mercury*). Dated August 11th.

14,533. "An apparatus for converting alternating currents of electricity into direct currents." R. N. LUCAS and A. G. NEW. Dated August 11th.

14,558. "Improvements in lampholders for incandescent electric lamps." C. M. DORMAN and R. A. SMITH. Dated August 12th. (*Complete.*)

14,567. "Improvements in grooved wood cases for electric cables or wires." S. HINDLEY. Dated August 12th.

14,580. "A magnetic frictional brush." L. LOHIER. Dated August 12th.

14,647. "Apparatus for controlling the electric current on putting electromotors in circuit." SIEMENS BROTHERS & Co., LIMITED. (Communicated by Messrs. Siemens & Halske, Germany.) Dated August 13th.

14,658. "Improvements relating to electric accumulators or secondary batteries, and to the manufacture of plates or electrodes therefor." A. J. SMITH. Dated August 13th.

14,659. "Improvements in and relating to electric accumulators." H. H. LAKE. (Communicated by F. C. Jenkins, Germany.) Dated August 13th.

14,660. "Improvements in and relating to the manufacture of plates for electric accumulators." J. ROUSSEAU. Dated August 13th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

889. "Apparatus for manufacturing corrugated lead boxes for electric accumulators." WOODHOUSE AND RAWSON UNITED, LIMITED. (Communicated from abroad by T. K. Steanes, of Sydney.) Dated January 17th. A hydraulic or other press is employed to push up a plunger within a die which is charged with a suitable quantity of lead, both the plunger and the die being corrugated. At the same time that the plunger is forced upwards, another plunger is forced a little way downwards into the die, this plunger being somewhat smaller than the die by the quantity due to the thickness of the box that is to be manufactured. By the ascent of the bottom plunger the lead is forced out of the upper mouth of the die around the upper plunger until the box is formed to the depth provided for by the charge of lead in the die. The upper plunger with the moulded box on it is then raised out of the die and turned aside upon a hinge at the top, so that the moulded box can be withdrawn from off it. 2 claims.

1,046. "Improvements in apparatus for prepaid telephonic messages." R. H. GOULD and T. GOTTSCHALK. Dated January 20th. Has reference to apparatus for use with a telephone or microtelephone with call bell, for preventing the use of the telephone until after the insertion into the apparatus of a suitable coin or coins, or of a token or tokens of determined size, shape and weight, at a convenient part of the apparatus. 4 claims.

1,639. "Improvements in condensers for alternating electric currents." J. SWINBURNE. Dated January 29th. The condensers are made by heating thin paper, preferably of the kind known in the trade as butter skin, to a temperature of about 100° C. for some time. When thoroughly dried by this means, the paper is soaked in a hydrocarbon, such as paraffin oil. Sheets of tinfoil are used as plates, and the whole condenser is sealed up in an air-tight case. 8 claims.

1,680. "A new or improved process for the manufacture of wire for transmitting electric currents." A. E. TAVERNIER. Dated January 29th. Has for its object the production of a wire of a certain diameter by electro-deposition, such wire being afterwards converted into a wire suitable for the transmission of electricity by means of rolling and drawing. 5 claims.

4,554. "Improvements in armatures for electrical machinery." G. F. REDFERN. (Communicated by Messrs. Wirth & Co., of Frankfort-on-the-Main.) Dated March 13th. Grooves or recesses of the armature are lined with fibre, in such a way that every alternate lining of the wall of a groove projects out of it. The grooves are now first wound full, and the surface of the armature covered with insulating fibre. The projecting strips of fibre now form divisions, and in these, armature coils are again wound. 3 claims.

4,583. "Improvements in electric supply meters." J. PERRY. Dated March 14th. Relates to improvements in the apparatus described in specifications, No. 873 of 1890, and No. 2,642 of 1882. 4 claims.

CORRESPONDENCE.

Dynamos for Continuous Work.—The Output of Dynamos.

It happens in the affairs of electrical commerce that a dynamo of a certain ampère output is required, and this output is assumed by the party requiring the dynamo to be understood by the vendor of the dynamo as required continuously, that is, working day and night. This assumption has led, and still leads, parties requiring continuous running dynamos into experiences for which, as usual, they have to pay. I am by no means disposed, nor willing, to make too much of the point connected with the tickets that are placed on dynamos, in the usual form of volts, amps., and revs.; but I would suggest that dynamos should have the whole truth ticketed upon them.

Dynamos are labelled (having in view, probably, a lighting application for comparatively short periods), with a certain ampère output, and we will say that it is a thousand. But for how long? is the question. How many hours will the segments and brushes continue leading off this density before such a temperature arises that, without a number of additional agents in many forms, the density must either be decreased or the machine stopped?

I am beginning to make up my mind that there's nothing like coal. I know "there's nothing like leather." Call leather coal, and I am amenable; call a ticketed 1,000-ampére dynamo a 700-ampère dynamo, and I am still amenable. But to what? To a proper understanding. Therefore, ye men of windings, commutators, and brushes, and too little iron in one part or another, say what should be said. The lubrication of your spindle is nothing. But lubricate your tickets? Never! Emery in every case; and, finally, a cold chisel!

James C. Richardson.

August 17th, 1892.

Electric Sub-Station Supply.

"The Writer of the Article" on the above subject, in your last issue, makes the following comments upon our letter in your contemporary, *Lightning*, under date August 11th:—

"Messrs. Hammond & Co. . . . endeavour to claim installations erected by them as the earliest attempts to distribute electricity, citing Hastings, Eastbourne, and Brighton as installations erected in the 'early eighties,' and this firm sets itself up as the pioneer of high-tension alternating current distribution. Such claims are ridiculously absurd."

We are sure that the ELECTRICAL REVIEW has no wish to be otherwise than strictly accurate, and therefore wish to point out that in our letter no claims were made at all; but the simple fact was stated that the distribution systems laid down at Brighton, Eastbourne and Hastings, in the "early eighties" were *not*, as your writer said in his article, enlarged copies of isolated plants, and, as he obviously implied, *low-tension* direct current systems, but were high-tension systems, and are such to this day.

The word "alternating," as you have doubtless seen by our correction in last week's issue of your contemporary, was a copyist's addition to our letter, which simply obscured its point.

The Brighton station was begun as early as December, 1881, and was running by the beginning of 1882, so that Edison's "Jumbo" dynamos supplying Holborn Viaduct in 1882 cannot be said to have given this much of a start. Eastbourne and Hastings were completed, respectively, in 1882 and 1883. The curious fact, therefore, remains that though *all* of the pioneer central stations erected at this period were not on the high-tension principle, none but the high-tension stations have survived to the present day.

Low-tension stations may have a future before them, but their advocates had better avoid any reference to *pioneer* work in this country in the "early eighties," as stern facts are opposed to them.

Hammond & Co.

August 23rd, 1892.